GENERAL REPORT

SURVEY OF INDIA

1917-18 TO 1921-22

1908-09

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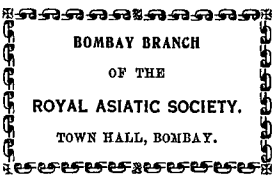

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Survey of India.

GENERAL REPORT,

1917–18.

From 1st October 1917
To 30th September 1918.

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PREPARED UNDER THE DIRECTION OF

COLONEL SIR S. G. BURRARD, K.C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1919

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4. Publication of modern one-inch series, Northern Circle.
5. ,, ,, ,, ,, Southern ,,
6. ,, ,, ,, ,, Eastern ,,
7. ,, provisional editions of one-inch series, Northern Circle.
8. ,, ,, ,, ,, ,, Eastern ,,
9. ,, modern half-inch series for India.
10. ,, ,, quarter-inch ,, ,,
11. ,, 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
12. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
13. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
14. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1917—18.

From 1st October 1917
To 30th September 1918.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shown in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XII of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 24,779* square miles; and that this brings the total progress since 1905 to 496,362 square miles, leaving 1,325,238 square miles still to be done.

3. The first three Index maps, at the end of the report, show the progress of this topographical programme both in survey and in publication in the three circles, while the remaining eleven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the survey of India is based.

4. Table IV on page 33 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

*This however excludes 408 square miles previously surveyed on a smaller scale.

6. The following events are notified:—

(*a*) Six Imperial Officers have reverted from temporary military duty.

(*b*) Owing to the shortage of officers the field work of the whole department was again considerably curtailed.

(*c*) The Survey party under an Imperial Officer (designated from 6th March 1918, Deputy Director of Surveys, Mesopotamian Expeditionary Force), which accompanied the field-force in Mesopotamia continued survey operations there.

(*d*) The Survey party under an Imperial Officer which was sent to Western Persia was amalgamated with the Survey party in Mesopotamia.

(*e*) The Survey party under an Imperial Officer which was ordered to carry out survey operations in Persia was disbanded.

(*f*) The Survey detachment in charge of a Provincial Officer which was sent to Salonika to serve under an Imperial Officer on military duty there, continued survey operations in that locality.

(*g*) A Survey detachment under a Provincial Officer attached to the Indian Army Reserve of Officers was despatched to East Africa for duty with Field Survey units of Royal Engineers.

(*h*) The General Officer Commanding, Northern Army, expressed his high appreciation of the unfailing promptitude with which maps were despatched by the Map Record and Issue Office, Calcutta.

(*i*) Lieut.-General Sir W. R. Marshall, K.C.B., K.C.S.I., Commanding-in-Chief, Mesopotamian Expeditionary Force, in his despatch dated the 15th April 1918 wrote as follows:—

"The work performed by the Surveys has assumed very "large proportions, but my demands have always been "met in the most satisfactory manner, and the Map "Compilation Section has been of the greatest assistance."

(*j*) A committee has been appointed to consider and report upon certain questions with regard to the future work of the department, which were raised at the meeting held in the Trigonometrical Survey Office, Dehra Dūn, on the 29th March 1918, at which the Hon'ble Sir Claude Hill, K.C.S.I., C.I.E., Member of the Governor General's Council, presided and the Hon'ble Mr. R. A. Mant, Secretary to the Government of India, Department of Revenue and Agriculture, was present.

(*k*) The re-opening of recruitment for the Provincial Service and the appointment of five officers every alternate year subject to re-consideration in 1925, were sanctioned by the Secretary of State.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1918 and of the two previous years is shown below:—

	1915-16.	1916-17.	1917-18.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	30,08,348	32,93,109	**38,15,068***	* These figures are not final.
Deduct receipts and credits	8,35,339	14,79,255	**17,71,617***	
Net actual cost ...	21,73,009	18,13,854	**20,43,451***	

8. Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S. administered the department throughout the year.

9. In the Imperial Service Colonel T. F. B. Renny-Tailyour, C.S.I., R.E., was granted an extension of service. The number of Imperial Officers temporarily reverted to military duty on account of the war at the end of the Survey year is 22.

In the Provincial Service Mr. A. Ewing (Retired) ceased to be re-employed. Mr. W. F. E. Adams died. Mr. J. Smith retired and Messrs. H. C. W. Stotesbury and T. P. Dewar resigned. The number of officers of the Provincial Service on deputation to military duty at the end of the Survey year is the same as that of last year, namely, 15.

In the Upper Subordinate Service 1 officer died and 2 officers retired.

The total strength of the department at the close of the Survey year was 46† Imperial Officers, 112‡ Provincial Officers and 51 Upper Subordinates besides specialists, clerks, lower subordinates and menials; but the number of officers of the first two services actually employed in the department, including those attached to Overseas Survey parties, but not the Provincial Officer attached to the Indian Army Reserve of Officers sent in charge of the Survey Detachment to East Africa, were 24 Imperial Officers and 97 Provincial Officers, the remainder being on military duty.

10. The following Honours were conferred on members of the department during the year:—

Companions of the Order of St. Michael and St. George.—
Brevet-Colonel F. W. Pirrie, C.I.E., I.A.
Brevet-Lieut.-Colonel C. M. Browne, D.S.O., R.E.

Companion of the Order of the Indian Empire.—
Major E. T. Rich, R.E.

Companions of the Distinguished Service Order.—
Lieut.-Colonel G. A. Beazeley, R.E.
Major (Temporary Lieut.-Colonel) M. O'C. Tandy, R.E.
Major R. H. Phillimore, R.E.
Major M. N. MacLeod, M.C., R.E.
Major (Temporary Lieut.-Colonel) F. F. Hunter, I.A.
Brevet-Major (Temporary Lieut.-Colonel) F. P. Nosworthy, M.C., R.E.

† Excluding the officer re-employed.
‡ Excluding officers re-employed and on deputation to Local Governments.

Bar to the Distinguished Service Order.—	Brevet-Major (Temporary Lieut.-Colonel) F. P. Nosworthy, D.S.O., M.C., R.E.
Awarded the Military Cross.—	Captain W. E. Perry, R.E.
Promoted to Brevet-Lieutenant-Colonel.—	Major H. Wood, R.E. Major A. A. McHarg, D.S.O., R.E.
Promoted to Brevet-Major.—	Captain K. Mason, M.C., R.E.
Mentioned in despatches.—	Brevet-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., (twice during the year, altogether six times). Lieutenant-Colonel G. A. Beazeley, D.S.O., R.E., (second time). Brevet-Lieut.-Colonel H. Wood, R.E., (second time). Brevet-Lieut.-Colonel C. P. Gunter, R.E. Major (Temporary Lieut.-Colonel) M. O'C. Tandy, D.S.O., R.E. Brevet-Lieut.-Colonel C. M. Browne, C.M.G., D.S.O., R.E., (fourth time). Major M. N. MacLeod, D.S.O., M.C., R.E. Major (Temporary Lieut.-Colonel) F. F. Hunter, D.S.O., I.A. Brevet-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E., (second time*). Brevet-Major K. Mason, M.C., R.E., (twice during the year, altogether thrice). Captain W. E. Perry, M.C., R.E. Brevet-Major (Temporary Lieut.-Colonel) F. P. Nosworthy, D.S.O., M.C., R.E., (fourth time†). Mr. J. McCraken, Extra Assistant Superintendent. Mr. W. H. Strong, Extra Assistant Superintendent. Mr. Nanak Chand Puri, B.A., Sub-Assistant Superintendent. Mr. Hamid Gul, Sub-Assistant Superintendent. Surveyor Ahmad Shah. Surveyor Sijawal Khan. Surveyor Mir Abdullah.
Member of the Order of the British Empire.—	Commissary and Honorary Major C. J. Arbery.
Title of Khan Sahib.—	Mr. Syed Zille Hasnain, Extra Assistant Superintendent.
Fellowship of the Royal Society.—	Colonel G. P. Lenox-Conyngham, R.E.
Fellowship of the Asiatic Society of Bengal.—	Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S.
Specially promoted to be Assistant Commissary with the Honorary rank of Lieutenant.—	Late Conductor W. Fitch, Draftsman, of the Army Section of No. 6 Drawing Office, (Simla).

* Major Hamilton was mentioned the first time in Field Marshal Sir Douglas Haig's despatch of 30th April 1916.

† Including the mention in Field Marshal Sir John French's despatch, dated the 14th January 1915.

Services brought to the notice of the Government of India.—

Arbery, Commissary and Honorary Major C. J., Officer in charge, No. 6 Drawing Office (Simla).

Burrard, Colonel Sir Sidney G., K.C.S.I., R.E., F.R.S., Surveyor General of India.

Ferrier, Mr. T. A., Officer in charge, Mathematical Instrument Office.

Graham, Assistant Commissary and Honorary Lieutenant R., Draftsman, Army Section, No. 6 Drawing Office (Simla).

Greiff, Mr. J. O., Deputy Superintendent.

Ryder, Lieutenant-Colonel C. H. D., C.I.E., D.S.O., R.E., Superintendent.

Smith, Conductor W., Draftsman, Army Section, No. 6 Drawing Office (Simla).

Honorarium of Rs. 1,000.—

Mr. S. Woodhouse, Works Manager, Mathematical Instrument Office, Calcutta.

11. The following table shows the distribution of officers during the year: The names of officers on deputation to Local Governments or military duty (except Lieutenant A. J. A. Drake, D.C.M.) or absent on long leave throughout the year are omitted.

TABLE I—DISPOSITION OF OFFICERS, 1917-18.

SURVEYOR GENERAL OF INDIA—Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Lieut.-Colonel H. H. Turner, R.E. Lieut.-Colonel A. Mears, I.A.			
No. 6 Drawing Office, Simla.	Major C. J. Arbery	Mr. Dhani Ram Verma ,, Asmat-ullah Khan, K.S.		26 Draftsmen, &c.
Mesopotamian Survey Party.*	Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E. Bt.-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A. Lieut.-Colonel G. A. Beazeley, D.S.O., R.E. Bt.-Lieut.-Colonel C. P. Gunter, R.E. Major E. T. Rich, C.I.E., R.E. ,, L. C. Thuillier, I.A. ,, L. G. Crosthwait, I.A. Mr. J. deGraaff Hunter, M.A. Major A. H. Gwyn, I.A. Captain C. G. Lewis, R.E. ,, W. E. Perry, M.C., R.E.	Mr. S. S. McA'F. Fielding ,, C. West ,, E. C. O'Sullivan, D.C.M. ,, D. K. Rennick ,, F. B. Kitchen ,, W. H. Strong ,, A. J. Booth ,, J. C. St. C. Pollett	Mr. Nanak Chand Puri, B.A. ,, Hamid Gul ,, Bhamba Ram ,, Annada Prasad Ghosh ,, Laltan Khan	39 Surveyors, &c.
Persian Survey Party. †	Major E. T. Rich, C.I.E., R.E.	Mr. A. F. Murphy	Mr. Sher Jang, K.B.	2 Surveyors.
Western Persia Survey Party. ‡	Captain W. E. Perry, R.E.	Mr. D. K. Rennick	Mr. Hamid Gul ,, Laltan Khan	3 Surveyors.
East Africa Survey Detachment.		Lieutenant A. J. A. Drake, D.C.M. (*Indian Army Reserve of Officers*).	Mr. Ram Prasad, B.S.	5 Surveyors.

SUPERINTENDENT, MAP PUBLICATION— *Lieut.-Colonel W. M. Coldstream, R.E. (Temporarily reverted to military duty).* Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E. Lieut.-Colonel H. H. Turner, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Lieut.-Colonel H. H. Turner, R.E. Lieut.-Colonel A. Mears, I.A. Major E. T. Rich, C.I.E., R.E. ,, O. H. B. Trenchard R.E.	Mr. P. Williams ,, Jagdamba Prasad ,, Abinash Chunder Bose ,, C. West ,, Priya Nath Sur ,, A. A. Graham ,, T. F. Kitchen ,, H. T. Hughes ,, H. H. P. Butterfield ,, Jiya Lal Sahgal		
Photo.-Litho. Office, Calcutta.	Captain F. J. M. King, R.E.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).		Mr. P. Simpson ,, Priya Nath Sur		

* Formerly known as the Basrah Survey Party.
† Disbanded in January 1918.
‡ Amalgamated with the Basrah (now Mesopotamian) Survey Party on 1st February 1918.

TABLE I –(Continued).—DISPOSITION OF OFFICERS, 1917-18.

SUPERINTENDENT, NORTHERN CIRCLE { Lieut.-Colonel C. L. Robertson, C.M.G., R.E., upto 15th March 1918. Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., from 16th to 30th March 1918. Colonel G. P. Lenox-Conyngham, R.E., F.R.S., from 31st March to 9th April 1918. Lieut.-Colonel H. L. Crosthwait, R.E., from 10th April 1918.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.		Mr. J. A. Freeman „ E. B. West	Mr. Imam Din	29 Draftsmen, &c.
No. 1 Party, *Punjab and N.-W. F. Province.*	Major E. A. Tandy, R.E.	Mr. G. R. Hughes „ G. J. S. Rae „ H. P. D. Morton „ P. A. T. Kenny „ R. C. Hanson „ G. A. Norman	Mr. Sher Jang, K.B. „ Jagdeesh Prasad Vastav „ Afraz Gul Khan, *Probationer.*	48 Surveyors, &c.
No. 2 Party, *Rājputāna, United Provinces and Delhi Province.*		Mr. T. W. Babonau „ H. P. D. Morton „ R. E. Sauballe „ J. H. Johnson „ J. A. Calvert „ Duni Chand Puri	Mr. Ghulam Hasan „ Daulat Ram Vohra	35 Surveyors, &c.
No. 3 Party, *United Provinces.*		Mr. H. H. B. Hauby „ E. J. Biggie „ A. M. Talati, L.C.E. „ G. E. R. Cooper „ Moqimuddin	Mr. Muhammad Husain „ Amir Abdul Salam Matlub Ahmad	44 Surveyors, &c.
No. 4 Party,	Lieut.-Colonel H. L. Crosthwait, R.E. Bt.-Lieut.-Colonel A. A. McHarg, D.S.O., R.E.	Mr. Dhani Ram Verma		1 Clerk.
Sind-Sāgar Party, *Punjab.*	Lieut.-Colonel H. L. Crosthwait, R.E.	Mr. Dhani Ram Verma „ J. C. C. Lears „ F. J. Grice	Mr. Chuni Lal Kapur „ Muhammad Husain Khan „ Nabidad Khan	26 Surveyors, &c.
Riverain Detachment, *Punjab.*		Mr. Maya Das Puri, B.S.	Mr. Pams Ram „ Ram Narayan Hastir „ Lakshmi Datt Joshi „ Vidya Dhor Chopra	78 Surveyors, &c.

SUPERINTENDENT, SOUTHERN CIRCLE Colonel T. F. B. Renny-Tailyour, C.S.I., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.		Mr. J. H. Nichol „ F. P. Walsh „ V. W. Morton „ F. C. Pilcher	Mr. B. V. Narayana Rao	27 Draftsmen, &c.
No. 5 Party, *Berār, Bombay, and Central Provinces.*		Mr. P. R. Anderson „ Haji Abdul Rahim, K.B.	Mr. Dhondur Khadilkar	27 Surveyors, &c.
No. 6 Party, *Hyderābād and Madras.*		Mr. J. O'B. Donaghey „ E. A. Meyer „ Munshi Lal, B.A. „ F. W. Smith „ M. S. Ganesa Aiyar	Mr. Eknath Battu „ Ram Narayan Hastir „ K. Mandanna „ Musaf Khan	34 Surveyors, &c.
No. 7 Party, *Madras.*		Mr. W. M. Gorman „ F. H. Grant „ B. T. Wyatt „ N. S. Hariharа Iyer	Mr. Abdul Hakk, K.S. „ P. S. Venguswami „ Shib Lal „ Shaikh Muhammad Salik „ E. N. Natesan, B.A. „ Pulin Behari Roy „ Jitendra Mohan Mukerji	30 Surveyors, &c.
No. 8 Party, *Madras and Mysore.*		Mr. W. F. E. Adams (Died 26th January 1918). „ C. E. C. French „ V. W. Morton „ M. Mahadeva Mudaliar, M.A.	Mr. K. Narayanasvami Chetti „ H. Narasimhamurti Rao	29 Surveyors, &c.
No. 20 Party, *Cantonments and Military Stations in 3rd, 4th, 5th, 6th, 7th and 9th Divisions.*		Mr. A. Ewing (Ceased to be re-employed on 30th April 1918). „ B. R. Hughes „ F. C. Pilcher „ O. D. Jackson	Mr. Dharma „ Jitendra Mohan Mukerji	25 Surveyors, &c.
Training Section, *Mysore.*		Mr. S. F. Norman	Mr. Hari Ram Chandra Jogalekar	18 Surveyors and Pupils.
Salonika Survey Detachment.		Mr. H. B. Simons	Mr. Jamna Prasad, R.S.	8 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1917-18.

SUPERINTENDENT, EASTERN CIRCLE

Lieut.-Colonel R. T. Crichton, C.I.E., I.A., up to 29th March 1918.
Lieut.-Colonel C. L. Robertson, C.M.G., R.E., from 30th March to 7th May and from 20th June 1918.
Lieut.-Colonel A. Mears, I.A., from 8th May to 19th June 1918.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.		Mr. J. H. S. Wilson ,, E. Claudius ,, E. M. Kenny		23 Draftsmen, &c.
No. 9 Party, *Bengal.*		Mr. J. Smith (Retired 14th September 1918). ,, E. J. Biggie ,, A. B. Hunter ,, B. C. Newland ,, Amar Krishna Mitra	Mr Amulya Charan Ghosh ,, Gopal Lal Mitra	23 Surveyors, &c.
No. 10 Party, *Upper Burma.*		Mr. M. C. Potters ,, W. G. Jarbo ,, H. H. Creed ,, A. V. Dickson ,, Dhirendra Nath Banerjee, L.C.E.	Mr. Hayat Muhammad, K.S. ,, Maung Kyaw Nyein (Retired 16th June 1918). ,, Dhirendra Nath Saha ,, Ram Prasad, R.S.	23 Surveyors, &c.
No. 11 Party, *Lower Burma.*		Mr. J. O. Greiff ,, C. E. C. French ,, O. J. H. Hart ,, E. M. Kenny ,, C. O. Picard	Mr. Lachman Daji Jadu, R.B. (Retired 19th August 1918). ,, Dalbir Rai ,, Pratul Chandra Sen Gupta, B. Sc.	34 Surveyors, &c.
No. 12 Party, *Assam, Sikkim and Bhutan.*		Mr. H. W. Biggie ,, E. G. Hardinge ,, Pramadaranjan Ray, R.S. ,, Prafulla Chandra Mitra, B.A. ,, K. S. Gopalachari, B.A.	Mr. Girija Sonker Bagchi	29 Surveyors, &c.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY—Colonel G. P. Lenox-Conyngham, R.E., F.R.S.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	*(Attached)* Colonel R. A. Wauhope, C.B., C.M.G., C.I.E., R.E.	Mr. H. A. Charrier		
Computing Office	Major H. McC. Cowie, R.E.	Mr. Hanuman Prasad	Mr. Sarat Kumar Mukerji ,, Karuna Kumar Das, B.A.	41 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Colonel R. A. Wauhope, C.B., C.M.G., C.I.E., R.E.	Mr. O. C. Ollenbach ,, C. C. Byrne ,, H. C. W. Stotesbury (Resigned 16 March 1918). ,, Rama Prasad Ray, B.A. ,, O. N. Pushong ,, J. McCraken ,, Raj Bahadur Mathur, B.A. ,, Abdul Karim, B.A. ,, A. F. Murphy	Mr. Lal Singh, R.B. ,, Ram Singh, R.S.	103 Draftsmen, &c.
No. 13 Party, *(Astronomical).*	Major H. McC. Cowie, R.E.			1 Computer.
No. 14 Party, *(Pendulum).*	Major H. McC. Cowie, R.E.			1 Computer.
No. 15 Party, *(Triangulation).*	Major E. A. Tandy, R.E.	Mr. H. G. Shaw ,, L. Williams ,, Raj Bahadur Mathur, B.A. ,, Abdul Karim, B.A. ,, Narendra Nath Chuckerbutty, L.C.E.	Mr. Jugal Behari Lal	13 Computers, &c.
No. 16 Party, *(Tidal).*		Mr. O. C. Ollenbach ,, Syed Zille Hasnain, R.S.		20 Computers, &c.
No. 17 Party, *(Levelling).*		Mr. H. G. Shaw ,, D. H. Luxa ,, J. McCraken ,, Narendra Nath Chuckerbutty, L.C.E.	Mr. Satish Chandra Mukerjee	10 Computers, Recorders, &c.
No. 18 Party, *(Magnetic).*		Mr. E. C. J. Bond ,, Rama Prasad Ray, B.A. ,, Nikunjo Ronjon Mazumdar	Mr. Karuna Kumar Das, B.A. ,, Ridhu Bhusan Shome	2 Magnetic Observers. 12 Computers, &c.
No. 19 Party, *(Base Line).*	Major E. A. Tandy, R.E. ,, H. McC. Cowie, R.E. ,, E. T. Rich, C.I.E., R.E. Captain W. E. Perry, M.C., R.E.	Mr. E. C. J. Bond		2 Computers, &c.

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

12. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905 and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shown in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 590,000 square miles are likely to be surveyed on the half-inch or smaller scale.

Table II. Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
1917-18 ...	ditto ...	4,202	12,181*	8,396	24,779
Total areas completed to date ..		**211,801**	**155,167**	**129,394**	**496,362**
Approximate areas for the whole topographical programme.		**750,000**	**542,800**	**528,800**	**1,821,600**
Approximate areas remaining for survey.		**538,199**	**387,633**	**399,406**	**1,325,238**

* Excluding 408 square miles previously surveyed on a smaller scale.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1917-18.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
NORTHERN CIRCLE.						
No. 1 Party—*Punjab and North-West Frontier Province.*						
Broken low hills	1-inch Original Survey ...	7				
Plains mostly cultivated but small portions wooded.	1-inch Revision Survey ...	347				
Broken Siwālik foot-hills and open valleys.	1-inch Supplementary Survey ...	1,207	1,868	92,404 (a)	49·5	(a) Excludes Rs. 3,080 incurred for fair-mapping of 4 inches = 1 mile Military Survey at Peshāwar of which survey and portion of fair-mapping were carried out in previous season 1916-17.
Partly Siwāliks, partly plains. ...	3-inch Original Survey Military	307				
No. 2 Party—*Rājputāna, United Provinces and Delhi Province.*						
Narrow plains and hills of an intricate nature.	½-inch Original Survey ...	1,286				
Open plains and low hills ...	3-inch Original Survey Military	187	1,617	46,231 (b)	28·6	(b) Excludes Rs. 30,000 debitable to the Forest Department.
High hills densely forest-clad ...	4-inch Supplementary Special Forest Survey.	144				(c) The areas surveyed on half-inch and 4-inch scales have not been mapped.
No. 3 Party—*United Provinces.*						
Wooded hills	1-inch Revision Survey ...	105				
Ditto	2-inch Original Survey ...	459	717	87,182 (d)	121·6	(d) Excludes Rs. 8,614 debitable to the Forest Department.
Undulating and low wooded hills	3-inch Original Survey Military	31				
Wooded hills	4-inch Original Special Forest Survey.	122				
TOTALS, NORTHERN CIRCLE:—		4,202 sq. m.		Rs. 2,25,817	Cost-rate 53·7	
SOUTHERN CIRCLE.		*Sq. miles.*		*Rs.*	*Rs. per sq. mile.*	
No. 5 Party—*Berār, Bombay and Central Provinces.*						
Well-wooded cultivated plains ...	1-inch Original Survey ...	570				
Wooded intricate hills ...	1-inch Revision Survey ...	527	1,214	41,719(f)	34·4	(e) This area has been previously surveyed on a smaller scale.
Undulating	3-inch Original Survey Military	58				
Ditto	3-inch Resurvey Military ...	59 (e)				(f) Excludes Rs. 14,129, cost of ½-inch mapping.
No. 6 Party—*Hyderābād and Madras.*						
Hilly and undulating ...	½-inch Original Survey ...	6,675				
Wooded hills ...	1½-inch Original Survey ...	188	7,114	1,04,549	14·7	
Ditto ...	1½-inch Resurvey ...	271(e)				
Open and rocky hills ...	3-inch Resurvey Military ...	30(e)				
No. 7 Party—*Madras.*						
Varied, mostly undulating ...	1-inch Original Survey ...	2,940				
Wooded and hilly ...	1-inch Supplementary Survey	478	3,626	89,931	24·8	
Wooded, undulating and low hills ...	2-inch Original Survey ...	163				
Wooded, undulating and hilly ...	4-inch Original Survey ...	45				
No. 8 Party—*Madras and Mysore.*						
High densely wooded hills and plains	1-inch Original Survey ...	482				
High wooded hills	1-inch Revision Survey ...	155	635	35,734(g)	56·3	(g) Excludes Rs. 19,706, cost of ½-inch mapping.
Open and undulating	3-inch Resurvey Military ...	48 (e)				
TOTALS, SOUTHERN CIRCLE:—		12,589 sq. m.		Rs. 2,71,933	Cost-rate 21·6	

Table III.—(Concluded).—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1917-18.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
						EASTERN CIRCLE.
No. 9 Party—*Bengal.*						
Flat and cultivated plains	1-inch Original Survey ...	2,184	2,218	73,864 (*h*)	28·3 (*i*)	(*h*) Includes a sum of Rs. 10,980 on account of special large scale surveys. (*i*) Has been arrived at after excluding the sum of Rs. 10,980 on account of special large scale surveys.
Ditto ditto	1-inch Revision Survey ...	34				
No. 10 Party—*Upper Burma.*						
Mountainous and densely wooded ...	½-inch Original Survey ...	2,501	3,325	1,44,640 (*j*)	43·5	(*j*) Includes Rs. 14,322 cost of Instruction Camp.
Mountainous and densely wooded with intricate foot-hills.	1-inch Original Survey ...	824				
No. 11 Party—*Lower Burma.*						
High hills densely wooded without roads and villages.	1-inch Original Survey ...	1,158	1,475	1,90,840 (*k*)	118·8	(*k*) The cost of drawing office during field season (Rs. 15,629) has been excluded in calculating cost-rate.
High hills and low undulating ground densely wooded.	2-inch Original Survey ...	282				
Low hills and undulating plains densely wooded.	4-inch Original Survey ...	35				
No. 12 Party—*Assam, Sikkim and Bhutan.*						
Plains and hills, partly under cultivation and partly densely wooded.	1-inch Original Survey ...	1,187	1,378	1,06,116	77·0	
Densely wooded plains and hills ...	2-inch Original Survey ...	191				
TOTALS, EASTERN CIRCLE:—		8,396 sq. m.		Rs. 5,15,400	Cost-rate 61·4	
GRAND TOTALS:		25,187 sq. m.		Rs. 10,13,150	Cost-rate 40·2	

NORTHERN CIRCLE (*vide* Index map No. 1).

13. No. 1 Party.—Surveyed an area of 1,561 square miles on the scale of 1 inch = 1 mile in parts of Chamba and Simla Hill States, and in the districts of Hoshiārpur, Kāngra and Jullundur of the Punjab. The country consisted of Himālayan foot-hills and adjacent plains.

Four Royal Artillery Practice Camps, comprising an area of 307 square miles, were surveyed on the scale of 3 inches = 1 mile in the vicinities of Peshāwar, Hoshiārpur and Quetta, two being near Quetta.

14. No. 2 Party.—Surveyed an area of 1,286 square miles on the half-inch scale in Jaipur and Alwar States (Rājputāna), and 144 square miles of forest survey on the 4-inch scale in Tehrī State. Two Royal Artillery Practice Camps on the 3-inch scale, comprising an area of 187 square miles, were surveyed near Delhi and Roorkee for the military authorities.

Supplementary triangulation was carried over an area of 156 square miles for future forest surveys, and 175 linear miles of forest boundaries were traversed. The Artillery Practice Camps entailed supplementary triangulation over an area of 40 square miles, with 55 linear miles of traversing.

The Rājputāna area consisted of narrow valleys divided by rocky hills rising about 1,000 feet above them and covered with dense brushwood.

15. No. 3 Party.—Surveyed a total area of 686 square miles in the Naini Tāl, Garhwāl and Almorā districts of the United Provinces, of which 105 square miles was revision survey on the 1-inch scale, 459 square miles '2-inch forest survey,' and 122 square miles 4-inch forest survey. The Royal Artillery Practice Camp, Kutwa, near Mirzāpur, comprising an area of 31 square miles, was surveyed on the 3-inch scale for the military authorities. In addition 1,122 square miles and 315 linear miles were respectively triangulated and traversed in advance.

The country surveyed was throughout hilly and densely wooded.

16. No. 4 Party.—Work was in abeyance during the year, the staff having been drafted to other parties.

17. Training.—Nine soldier-surveyors and fourteen pupils commenced training under No. 1 Party, of these 7 soldier-surveyors received instruction on the Artillery Practice Camp surveys near Quetta, and the remainder were put through a course of drawing.

18. Recess Work.—Fair-mapping has been impeded by special work on Artillery Practice Camp maps, and by the transfer of many of the best draftsmen to Mesopotamia and elsewhere.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on the 30th September 1918:—

Sheets on the half-inch scale ...	... 4
Do. one-inch ,, ...	... 37
Do. two-inch ,, ...	... 12
Royal Artillery Practice Camp Maps	... 1

19. Particulars of special work done by Nos. 1, 2, 3, and the Sind-Sāgar Parties and by the Riverain Detachment, are given on pages 41 and 17.

SOUTHERN CIRCLE (*vide* Index map No. 2).

20. No. 5 Party.—This party surveyed an area of 1,097 square miles on the one-inch scale in the Akola, Amraotī and Buldāna districts of Berār and in the Nimār district of the Central Provinces, and triangu-

lated an area of 2,747 square miles in the Chhindwāra, Jubbulpore, Mandlā, Narsinghpur and Seoni districts of the Central Provinces. The country surveyed consists of well-wooded, cultivated plains and of jungle-clad hills. A portion, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-mapping of half-inch sheets compiled from published sheets of the one-inch map.

In addition, the Royal Artillery Practice Camps of Aundh, 4th Division, an area of 58 square miles, and of Barelā, 5th Division, an area of 59 square miles, were surveyed on the three-inch scale for the military authorities.

21. No. 6 Party.—This party surveyed an area of 7,084 square miles on different scales in the Parbhani, Nānder, Bīdar, Gulbarga, Medak, Atrāf-i-balda and Mahbūbnagar districts of Hyderābād, triangulated an area of 6,408 square miles in the Atrāf-i-balda, Mahbūbnagar, Nalgonda and Warangal districts of Hyderābād and in the Kistna district of Madras, and traversed 95 linear miles in the Bidar, Gulbarga and Atrāf-i-balda districts of Hyderābād. The country surveyed is hilly and undulating with cultivation except in the hilly portions.

In addition, the Royal Artillery Practice Camp of Kāpra, 9th Division, an area of 30 square miles, was surveyed on the three-inch scale for the military authorities.

22. No. 7 Party.—This party surveyed an area of 3,626 square miles on different scales in the Nellore and Cuddapah districts of Madras, and triangulated an area of 2,723 square miles in the Kurnool, Cuddapah and Anantapur districts of Madras. The country surveyed embraces a portion, mostly reserved forests, of the Eastern Ghāts and an undulating expanse of cultivated and wooded lands, studded with isolated hills, between the foot of these Ghāts and the sea-coast.

23. No. 8 Party.—This party surveyed an area of 587 square miles on the one-inch scale in the Tinnevelly district and the Travancore State of Madras, and traversed 741 linear miles in the Tinnevelly, Rāmnād and Madura districts and the Travancore State. The highlands of this area are a region of wild, rocky and mountainous forms, clothed with impenetrable forest and terminating abruptly in the fertile plains of the Tinnevelly district. The remote inaccessibility of the hill tracts and the absence of communications rendered the problems of survey, labour and transport most difficult, entailing considerable hardships on the members of the party. A portion, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-mapping of half-inch sheets compiled from published sheets of the one-inch map.

In addition, the Royal Artillery Practice Camp of Rājankunti, 9th Division, an area of 48 square miles, was surveyed on the three-inch scale for the military authorities.

24. Training Section.—This section took the field in the Kolār district of Mysore. 17 pupil surveyors received instruction in topographical surveying.

25. Recess Work.—The whole of the area surveyed this year should be fair-mapped by the end of 1918-19.

26. The report on the survey of cantonments and military stations, undertaken by No. 20 Party, is entered on pages 17 and 18.

NORTHERN CIRCLE (*vide* Index map No. 1).

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Do. two-inch „ ...	... 12
Royal Artillery Practice Camp Maps	... 1

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SOUTHERN CIRCLE (*vide* Index map No. 2).

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lated an area of 2,747 square miles in the Chhindwāra, Jubbulpore, Mandlā, Narsinghpur and Seoni districts of the Central Provinces. The country surveyed consists of well-wooded, cultivated plains and of jungle-clad hills. A portion, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-mapping of half-inch sheets compiled from published sheets of the one-inch map.

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In addition, the Royal Artillery Practice Camp of Kāpra, 9th Division, an area of 30 square miles, was surveyed on the three-inch scale for the military authorities.

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In addition, the Royal Artillery Practice Camp of Rājankunti, 9th Division, an area of 48 square miles, was surveyed on the three-inch scale for the military authorities.

24. Training Section.—This section took the field in the Kolār district of Mysore. 17 pupil surveyors received instruction in topographical surveying.

25. Recess Work.—The whole of the area surveyed this year should be fair-mapped by the end of 1918-19.

26. The report on the survey of cantonments and military stations, undertaken by No. 20 Party, is entered on pages 17 and 18.

EASTERN CIRCLE (*vide* Index map No. 3).

27. No. 9 Party.—The topographical survey executed by this party on the 1-inch scale lay in the Burdwān, Hooghly, Nadiā and Jessore districts of Bengal. Advance traversing of 2,020 square miles, for detail survey in 1918-19, or subsequent years, was also carried out in the Nadiā, Hooghly, Howrah, Jessore, Khulnā and Twenty-four Parganas districts of Bengal. The area surveyed and traversed consists of flat and well-cultivated plains cut up by numerous rivers and swamps and interspersed with well-wooded villages and clumps of trees. Villages cluster thickly on both banks of the Hooghly and all the large streams which flow through the work. The country is well provided with roads and railways.

28. No. 10 Party.—The districts of Upper Burma in which this party worked were those of Myitkyinā and Putao. In addition to the plane-tabling mentioned in Table III as having been completed by it, it also triangulated an area of 3,084 square miles in Putao district in advance for detail survey on the scales of one-inch and half-inch to the mile. The country surveyed in Putao district consisted of the high mountainous tract at the headwaters of the Irrawaddy river, and ranged in altitude from 1,200 feet to 19,000 feet above mean sea-level. There are no roads and villages over large areas of this tract, and below 15,000 feet the slopes are covered with dense forest-growth. In the Myitkyinā district, the area surveyed varies in elevation from 600 feet to 5,000 feet and is cut up by numerous low-lying valleys, heavily wooded.

A small detachment remained in Putao district during the summer to complete the detail survey of the higher region at the source of the Irrawaddy river.

29. No. 11 Party.—In addition to the execution of the area of plane-tabling shewn in Table III, this party traversed 100 linear miles of forest boundary and ran 33 linear miles of other theodolite traversing for the purpose of fixing points in forest areas for the detail survey of those areas on the 2-inch and 4-inch scales. The 282 square miles and 35 square miles of plane-tabling on the 2-inch and 4-inch scales respectively constituted the detail survey of areas of reserved forest in the districts of Mergui, Tavoy, and Amherst.

2,780 square miles and 70 square miles of country in the Amherst district were triangulated in advance for purposes of detail survey in future years on the 1-inch and 4-inch scales respectively.

Generally speaking, the whole area, over which traversing and survey operations were extended, is densely wooded, the undergrowth consisting of tangled vegetation intermixed with cane and bamboo. The country comprised part of the upper valley of the Tenasserim river, and the upper reaches of the Tavoy river. In the Mergui district, except for a few Karen villages along the banks of the Tenasserim river, the country is uninhabited, and without roads of any description. Local labour throughout was most difficult to obtain, and the survey entailed considerable hardships on the members of the party.

30. No. 12 Party.—Of the area surveyed by this party on the 1-inch scale, 37 square miles lay on the Sikkim-Bhutān border, and were surveyed in connection with the settlement of a boundary dispute. The remainder lay in the districts of Lakhimpur and Sibsāgar and the Central and Eastern Sections of the North-East Frontier Tract of Assam, in which areas also lay the 2-inch surveys mentioned in Table III. These latter

were chiefly surveys of areas of reserved forest. 629 linear miles of traversing, covering an area of 1,519 square miles north of the Brahmaputra river in the district of Lakhimpur, was carried out to provide points for detail survey in 1918-19.

The area in Assam in which detail survey and traverse operations were carried out is covered for the most part by dense forest, consisting of trees and bamboos with undergrowth of scrub, cane and thorny creepers. It is interspersed with numerous tea gardens and rice cultivation, and, with the exception of a range of hills rising to 3,000 feet above sea-level lying within and along the southern limits of the area, and low hills in the south-west corner of the area which rise to 1,600 feet, is generally flat. The Brahmaputra, which is the principal river, flows through the northern half of the area. The area surveyed in Sikkim and Bhutān lies at altitudes varying from 6,000 to 12,000 feet above sea-level, and is densely clad in forest growth.

31. Recess work.—The fair-mapping of 2 sheets of which the survey had been completed prior to 30th September 1917 remained incomplete at the end of the year under report; while, of the sheets the survey of which had been completed during the latter year, all but 24 had been submitted by the parties for publication up to 30th September 1918.

Half-inch mapping from published modern 1-inch maps is dealt with on page 39.

II.—FOREST SURVEYS.

32. Details of the topographical surveys of reserved forests executed by field parties of the Survey of India for the year under report are given below. In the majority of cases the surveys were carried out on the scale of 2 inches to the mile but in special cases the four-inch and one-inch scales were used. Boundary surveys on the four-inch scale were made where required.

NORTHERN CIRCLE.

33. United Provinces. Kumaun Forest Circle.—Detail surveys on the 4-inch scale were executed in the *Nainī Tāl Forest Division* (85 square miles), and on the 2-inch scale in the *West Almorā Forest Division* (47 square miles), in the *South Garhwāl Forest Division* (71 square miles), making a total of 203 square miles; an area of 240 square miles in the *East Almorā Forest Division* was also triangulated in advance for survey on the 2-inch scale.

Western Forest Circle:—In the *Chakrātā Forest Division* a supplementary survey of 144 square miles on the 4-inch scale, of the Leased Forests in the Tehri-Garhwāl State, was completed; and, as a preliminary to a detail survey on the 4-inch scale, an area of 156 square miles of triangulation and 175 miles of boundary traversing were completed in the Bāwar, Badi, Deoband, Deogarh and Raingarh Forest Ranges.

SOUTHERN CIRCLE.

34. Madras. Central Forest Circle.—In the *Nellore District* an area of 45·858 square miles was surveyed on the 4-inch scale in the Udayagiri Velikonda Block and the Gundlakonda Reserve. In the same district the undermentioned areas were surveyed on the 2-inch scale:—Eight blocks in Udayagiri Tāluk (49·432 square miles), twelve blocks in the Atmakūr Tāluk (44·246 square miles), four blocks in the Kovūr Tāluk (15·710 square miles), and three blocks in the Rāpūr Tāluk (24·605 square miles) making a total of 133·993 square miles.

In the *Cuddapah District.*—An area of 30·190 square miles was surveyed on the 2-inch scale in two blocks of the Rāzampeta Tāluk.

EASTERN CIRCLE.

35. Assam. Eastern Forest Circle.—In the *Lakhimpur District*, the Dibru, Padumoni, Bharjān, Barajān, Jaipur, Takowāni, Kākojān and Upper Dihing (East Block) Reserved Forests, covering an area of 184·85 square miles, were surveyed on the 2-inch scale, and 51·06 miles of boundaries were traversed.

In the *North-East Frontier Tract*, the Kumsong and Sadiyā East and West Reserved Forests, covering an area of 11·68 square miles, were surveyed on the 1-inch scale.

36. Burma. Tenasserim Circle.—In the *Ataran Forest Division*, an area of 34·76 square miles in the Kyunchaung, Megwa, Mezali and Thingannyinaung Reserves was surveyed on the 4-inch scale, and 67·53 miles of boundaries were traversed.

In the *Tenasserim Forest Division*, an area of 281·86 square miles in the Heinze and Kaleinaung Reserves was surveyed on the 2-inch scale, and 32·15 miles of boundaries were traversed.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

37. The Punjab Riverain Detachment.—The detachment continued the work of traversing and laying down base lines. 440 linear, and 706 square miles of main circuits; and 3,904 linear, and 762 square miles of minor traverses were run; 780 theodolite stations of the former and 16,282 of the latter were fixed in the area under water action of 251 villages of the rivers Indus, Rāvi, and Sutlej in districts Dera Ghāzi Khān, Muzaffargarh, Multān, and Bahāwalpur State.

519 corners of 173 squares were demarcated in 1,181 square miles with permanent mark-stones on both banks of the Indus and the Rāvi, to serve as bases for the future survey and demarcation of boundaries and fields in the beds of the rivers. Some of the base lines on the Indus could not be fixed and were postponed to next season on account of the sites having been covered by floods.

2,935 plotted, and 816 boundary *masāvis* (settlement mapping sheets) on the scale of $\frac{1}{2,640}$, and 40 four-inch sheets were traced, and supplied in time to the Settlement Officers. Besides these, 377 miscellaneous traces were prepared, and all the traverse stations marked during the year were plotted on 58 four-inch sheets. The computation volumes still remain to be completed as the period of the recess is short.

Some of the Kāngra computation volumes have been completed and work in some still remains to be done.

38. No. 15 Party (Triangulation).—At the request of the Salt Department a large scale survey of the Mayo Salt Mine, Khewra (Punjab) was undertaken. Work was begun in November 1917 and finished in May 1918; it comprised the following operations:—

(*a*) A survey on the scale of 100 feet to an inch of the hill over the mine with contours at 20 ft. vertical interval. The area of the survey is about 290 acres.

(*b*) Triangulation to provide a framework for the above.

(*c*) Traversing inside the mine. The total length of the traverses is about 17,500 feet.

(*d*) Levelling for determining the heights of all the traverse and most of the triangulation stations and some bench-marks.

(*e*) Detailed survey of three selected chambers inside the mine.

(*f*) Astronomical observations for azimuth for the orientation of the map.

39. No. 20 Party.—During the year under report, the party was employed on the detail survey and mapping of the cantonments and military stations of Drosh, Chitrāl, Ghairat, Rāwalpindi, Topā, Jhelum, Siālkot, Dalhousie (Thatt Hill), Chaman, Manora, Neemuch, Deoli, Erinpura, Agar, Nasīrābād, Jhānsi, Ahmadnagar, Aurangābād, New Delhi, Hosūr Remount Dépôt, Drazinda, Jatta, Zām and Jandola on the 16-inch scale and on the survey of the *bāzārs* of Rāwalpindi, Siālkot, Manora, Neemuch, Deoli, Erinpura, Agar, Nasīrābād, Jhānsi, Ahmadnagar, Aurangābād and New Delhi on the 64-inch scale. The triangulation and traversing of Dalhousie (Thatt Hill), Manora, Erinpura, Agar, Aurangābād, Sātāra, New Delhi, Bellary and Hosūr Remount Dépôt were completed and the traversing of Secunderābād and Bolārum was commenced during the year. Forty-two fair sheets were submitted for publication during the year, and sixty fair sheets of cantonments and military stations and of *bāzārs*, the survey of which had been completed, were remaining at the end of the year.

The total out-turn of detail survey on the 16-inch scale was 26,527 acres and on the 64-inch scale was 314 acres. The total cost of surveying and mapping on the 16-inch scale was Rs. 50,870 and on the 64-inch scale was Rs. 6,632, and the cost-rate per acre was Rs. 1·9 and Rs. 21·1 respectively.

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scale of 16 inches = 1 mile, up to the end of 1917-18.

(1) Bakloh Cantonment.
(2) Bannu do.
(3) Dehra Dūn do.
(4) Fort Lockhart do.
(5) Guna do.
(6) Hangu do.
(7) Hāpur (Bābūgarh) Remount Dépôt.
(8) Jhelum Cantonment.
(9) Jullundur do.
(10) Kālka do.
(11) Kamptee do.
(12) Landour do.
(13) Meerut do.
(14) Peshāwar Cantonment.
(15) Quetta do.
(16) Quetta Civil Station.
(17) Rājkot Cantonment.
(18) Rāwalpindi do.
(19) Sahāranpur Remount Dépôt.
(20) Sanāwar Cantonment.
(21) Saugor do.
(22) Siālkot do.
(23) Simla Indian Infantry Lines.
(24) Thal Cantonment.
(25) Topa do.

IV.—THE TRIGONOMETRICAL SURVEY.

GEODETIC OPERATIONS.

40. No. 13 Party.—Astronomical.
No. 14 Party.—Pendulum. } —War conditions still continuing during the year under report, no latitude or pendulum operations were carried out and the personnel of these parties was employed at the Head-quarter offices and in continuing the calculation of the Hayford reduction for pendulum stations in India.

41. No. 15 Party.—Triangulation.—The party was employed in carrying out the following programme:

(a). Triangulation in the Sind-Sāgar Doāb.

The Triangulation, which is in character midway between minor and secondary, comprises two main series, one extending from Sanāwān in Muzaffargarh district to Khushāb in Shāhpur district and the other from Leiah in Muzaffargarh district to Miānwāli, with two small connecting series. Altogether 56 new stations were built and observations were taken at 107 stations including those built last year.

The triangulation was connected with five sides of the Great Indus Series of the Principal Triangulation and the results proved satisfactory.

(b). Survey of the Mayo Salt Mine, Kheora.

This survey is mentioned on page 17.

The table below gives details regarding the triangulation:—

Number of stations observed at	107
„ „ „ newly selected and built	56
Length of triangulation completed in miles	375
„ „ „ remaining to be done	*Nil*
Area of triangulation in square miles	1,950
Number of triangles observed	114
Maximum triangular error	9″·14
Average „ „	2″·39
Value of m	1·875
„ „ M	3·24
Theodolites used	T. & S., 6 inch micrometer Nos. 1,404, 1,097, 1,100 & 1,403.

42. No. 16 Party.—Tidal Operations.—During the year under report tidal registrations were carried out by means of self-registering tide-gauges at the stations given in the following list:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		Remarks.
1. Aden	1879 ...	Still working	39		
2. Karāchi ...	1868 ...	1880	*13	51	*With a small tide-gauge.
	1881 ...	Still working	38		
3. Bombay (Apollo Bandar)	1878 ...	„	40		
4. Bombay (Prince's Dock)	1888 ...	„	30		
5. Madras ...	1880 ...	1890	10	33	
	Restarted 1895	Still working	23		
6. Kidderpore	1881 ...	„	37		
7. Rangoon	1880 ...	„	38		
8. Moulmein ...	1880 ...	1886	6	15	
	Restarted 1909	Still working	9		
9. Port Blair	1880 ...	„	38		

In addition to the above, the actual records of high and low water at Bhaunagar, Chittagong and Akyab were obtained from tide-pole readings taken during day-light by the Port Officers concerned.

Hourly readings of a tide-gauge at Basrah were supplied to this department throughout the year by the Director of Inland Water Transport, Mesopotamia. The readings for the year commencing 1st January 1917 were reduced by the method of harmonic analysis and the constants thus deduced were used in the computation of data for the tide-tables for Basrah for 1919. These data were forwarded on 10th April 1918 to the National Physical Laboratory, Teddington, England, where tidal predictions were made from them with the aid of the tide-predicting machine. A set of the predictions was received from the Laboratory on 29th August 1918. The tide-tables for Basrah for 1919 are being printed at the Trigonometrical Survey Office at Dehra Dūn and will be despatched to the Director of Inland Water Transport, Mesopotamia, in October 1918.

Tidal registrations at the 9 observatories now working have, on the whole, been carried out satisfactorily and will be continued during the coming year.

All the above observatories were inspected during the year under report.

43. In the following table are given the annual and decadal percentages of error in the predicted times and heights of high and low water at all the stations where observations have been taken by self-registering tide-gauges :—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

YEAR.	AT OPEN COAST STATIONS.					AT RIVERAIN STATIONS.				
	Number of stations.	IN TIME.		IN HEIGHT.		Number of stations.	IN TIME.		IN HEIGHT.	
		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{10}$ of mean range at springs.		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{10}$ of mean range at springs.
		H.W.—L.W.		H.W.—L.W.	H.W.—L.W.		H.W.—L.W.		H.W.—L.W.	H.W.—L.W.
1908	6	84	84	98 97	99 99	2	58	52	77 60	97 92
1909	6	85	86	97 97	97 98	3	61	59	69 65	93 92
1910	6	81	83	98 98	95 96	3	57	52	63 71	89 94
1911	6	84	84	98 99	97 98	3	65	51	68 66	90 90
1912	6	82	82	97 98	97 98	4	70	58	74 62	94 91
1913	6	83	82	97 97	98 99	4	68	55	70 58	94 88
1914	6	77	79	96 97	98 98	3	75	67	71 55	92 84
1915	6	82	82	98 98	96 96	3	76	66	73 67	94 92
1916	6	81	82	96 97	96 99	3	81	68	73 62	93 87
1917	6	75	72	96 98	96 97	3	78	65	69 64	92 88
Average of ten years	...	81	82	97 98	97 98	...	69	59	71 63	93 90

44. No. 17 Party.—Levelling.—Two detachments were employed during the past season on levelling operations, the details of which are given below.

The out-turn, including branch lines, amounted to 285 miles of revisionary levelling and 152 miles of new levelling. The heights of 1 station of the Principal Triangulation and of 4 primary and 175 secondary new bench-marks were determined.

The revisionary levelling included :—*(i)* A line from Karamnāsā to Aurangābād. *(ii)* A line from Barākar to Burdwān along the Grand Trunk Road. These lines form parts of the Benares-Howrah line originally levelled in seasons 1913—17. *(iii)* A line from Rānchi *vid* Purūlia to

Barākar along the main road. This line is part of the line from Aurangābād *viâ* Daltonganj, Rānchī, and Purūlia to Barākar originally levelled in 1916-17.

The above revisionary levelling was undertaken in order to investigate (*a*) the large discrepancy amounting to nearly 2 feet between the difference in the heights of Benares and Howrah as determined by the old levelling of 1863-65 and 1881-83, and the new levelling of 1913-17 respectively, and (*b*) to try and discover whether the large closing error of about one foot in the circuit Rānchī-Barākar-Barhī-Rānchī, 312 miles in length, which was completed in 1916-17, was due to the levelling on the Rānchī-Barākar line, as this line, in which there is a fall of 1774 feet, was deemed suspicious.

The results of the revisionary levelling do not however disclose any serious errors in the levelling operations carried out in seasons 1913-17. For present purposes therefore and until the new net of modern levelling can be treated as a whole the amount of error to be assigned to each line, in order to remove the circuit error mentioned above and the discrepancy between the old and new results, has been determined by the method of minimum squares; and along each line the assigned portion of error has been dispersed by applying to the heights of the bench-marks corrections proportional to their distances from the starting point.

The new levelling consisted of a line from Cawnpore *viâ* Kālpī and Orai to Jhānsi, along the main road. This is a useful line both for geodetic and irrigation purposes.

45. No. 19 Party.—Base Line Operations.—Owing to the paucity of officers no Base Line work of any kind was undertaken during the year.

MAGNETIC SURVEY.

46. No. 18 Party.—Magnetic.—The magnetic observatories at Dehra Dūn and Toungoo were inspected by the Officer in charge during the field season and a complete set of observations was taken at each for the comparison of instruments. The Alībāg and Kodaikānal observatories, under the Meteorological Department, were also visited for the same purpose.

A permanently marked repeat station was established this season at Galle on the south coast of Ceylon. This station will be of much value for the determination of the annual changes in the magnetic elements in the South of India and in Ceylon.

No other field observations were taken during the year.

In 1919-20 the 75 repeat stations in India, Burma and Ceylon will be revisited. Favourable reports of the good preservation of the permanently marked repeat stations continue to be received from the local officials annually so that it will be possible in future to occupy exactly the same spot at each visit and it is hoped in consequence that the annual changes will be obtained with even greater accuracy than in the past.

Publication of the results of the Magnetic Survey. The original scheme of the magnetic survey consists of a general survey, and a detailed survey of magnetically disturbed areas. The general survey comprises 74 repeat stations and 1351 field stations in India, Burma and Ceylon, at which observations have been taken during the years 1901 to 1915; the reduction of these observations to the epoch 1909·0 has been completed and will be published shortly. The publication will contain a brief account

of the work of the Magnetic Survey during 1901—1915, with relative tables, and maps showing the lines of equal declination, dip, horizontal force and total force and the lines of equal annual change for each of the three elements.

The detailed survey comprises 11 magnetically disturbed areas in which observations of declination, dip and horizontal force were taken at 407 stations; the reduction of the observations at these stations is in hand and will be published later on.

The Magnetic elements at observatories.—The computation and tabulation of the provisional values of declination, dip, horizontal force and vertical force for the three observatories (Dehra Dūn, Toungoo and Kodaikānal) for 1917 have been completed; the mean values of these elements for the year 1917 derived from all days, excluding those of great disturbance, are given in the table below:—

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1917.

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 44·1	E 2 6·5	0·33010	0·3270
Toungoo ...	18 55 45 N 96 27 3 E	N 23 8·5	W 0 12·7	0·39037	0·16684
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 27·1	W 1 33·8	0·37661	0·029

PART 3.—OFFICE WORK.

1.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

47. The work of the Map Publication Office for the year under review again shows a large increase on the previous year's out-turn :—

(*a*) In the Photo.-Litho. Office the number of pulls on the machine and hand presses reaches a combined total of 4,796,813, giving 2,976,929 completed maps printed. The respective figures for last year were 3,954,954 pulls and 1,080,573 completed maps. As there was no increase of machine power during the year, the increased out-turn is due to more efficient working and constant overtime.

The increased demand for maps was due almost entirely to military requisitions. In order that the office may more easily cope with the ever increasing work, it has been decided to obtain two rotary offset machine presses from England, and it is hoped that by the aid of these machines the rapidity of the actual printing of maps will be greatly increased. Several improvements were introduced in the Photo.-Litho. Office during the year in the method of reproducing maps; these have added to the efficiency of the work and at the same time made the reproduction more economical.

(*b*) The increase in the number of maps printed necessarily entails an increase in the work of the Map Record and Issue Office. The total issues of maps this year has amounted to 883,543 as against 685,206 last year. In the majority of these issues the maps have been folded with stiffeners. The Issue Section of this office will be thoroughly overhauled during the coming year and placed on a much more satisfactory basis.

(*c*) In addition to the ordinary routine work in the Drawing and Engraving Offices, a large amount of extra-departmental work has been carried out and the out-turn compares most favourably with previous years.

(*d*) In the Mathematical Instrument Office there has again been a very large increase of work. The total value of issues for the current year is more than 50% in excess and the value of work done is more than 10% in excess of the previous year.

The strain on all these offices has been very great, as the extra work has been carried out without any increase of personnel.

48. The classes of maps for the publication of which the Head Quarter Offices are responsible, are as follows:—

(*a*) Topographical maps on the scale of 1 inch to 1 mile.

(*b*) Topographical maps on the scale of ½ inch to 1 mile.

(*c*) Topographical maps on the scale of ¼ inch to 1 mile.

(*d*) Geographical maps on the 1:1,000,000 scale (about 1 inch to 16 miles).

(*e*) Geographical maps on the 1:2,000,000 scale (about 1 inch to 32 miles).

(*f*) General maps on smaller scales.

(*g*) Special maps.

(a) **Topographical maps on the scale of 1 inch to 1 mile.**—During the year 43 modern sheets have been published. This is a further reduction on last year and is due both to a congestion of urgent military work in the Photo.-Litho. Office and to a reduction of field work on this scale.

22 one-inch sheets of those surveyed up to the end of September 1916 and 84 sheets of those surveyed up to the end of September 1917 remain to be published.

Index maps Nos. 4 to 6 at the end of this report show the progress made in the publication of the modern one-inch public sheets and the table below gives the annual output of the public sheets since the modern topographical surveys were begun:—

Year.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
1915-16	85	69	50	204
1916-17	23	40	22	85
1917-18	**18**	**12**	**13**	**43**
Total Published ...	644	435	443	1,522
Probable number of 1-inch sheets which will not be published owing to the area covered by them being included in the programme for sheets to be published on the ½-inch scale	911	564	473	1,948
Approximate number remaining for publication	597	1,030	1,121	2,748
Approximate number of public 1-inch sheets in India	2,152	2,029	2,037	6,218

In addition to the above, during the year 34 one-inch sheets, prepared from modern revenue surveys, have been published in colours pending their topographical revision. Village boundary editions of 2 modern one-inch sheets have been published at the request of Local Governments.

58 modern one-inch and 67 old style one-inch sheets were reprinted during the year.

(b) **Topographical Maps on the scale of ½ inch to 1 mile.** Index map No. 9 shows the progress made in the publication of these sheets. These maps now form the tactical map of India having taken the place of the quarter-inch maps in this respect. They were commenced in 1914 and most of them are reductions from the one-inch map, but others are from direct half-inch surveys.

The table below gives the annual out-put of these sheets :—

Year.	Drawn from component one-inch sheets.	Surveyed on half-inch scale.	Total.
1914-15	...	1	1
1915-16	21	4	25
1916-17	50	6	56
1917-18	**59**	**6**	**65**
Totals	130	17	147

(c) **The map of India on the scale of $\frac{1}{4}$ inch to 1 mile.** (*Vide* Index map No. 10).—This map is prepared in "degree sheets" which include 1° of latitude and 1° of longitude, *i.e.*, the area covered by 16 one-inch sheets, or four half-inch sheets.

The following table shows the progress made in publication of $\frac{1}{4}$" sheets within India :—

Years of Publication.	Number of Degree Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	1	3	3	7
1915-16	.....	1	4	5
1916-17	1	.....	3	4
1917-18	.....	.....	**4**	**4**
Totals	11	9	21	*41
Approximate number of "degree sheets" in India	170	140	140	450

* Eight of these are preliminary editions having been prepared from surveys executed prior to 1905 on various scales.

The production of the sheets on this scale is still delayed owing to the more urgent work on those of the half-inch scale.

26 sheets, prepared from the engraved quarter-inch Atlas sheets, have been brought up to date and published in black only as provisional "degree sheets" during the year.

With the exception of Rājputāna, Cutch and parts of Central India these provisional "degree sheets," including those in hand, now cover practically the whole of India where modern "degree sheets" are not likely to be available in the near future.

(d) **Geographical Maps on the 1:1,000,000 scale.**—(about 16 miles to 1 inch). (*Vide* Index map No. 11).—During the year 13 sheets of this series were published, either new or in new style to supersede old editions.

La Carte Internationale du Monde au 1,000,000ᵗ.—(*Vide* Index map No. 12).—A full description of the genesis of this series was given in the General Report for 1913-14. One sheet, No. N.E. 45, of this series has been published during the year. The sheets of this series are engraved on copper and transferred to zinc for facility of printing.

(e) **Geographical Maps on the 1:2,000,000 scale.**—(about 32 miles to 1 inch). (*Vide* Index map No. 13).—No map of this series was published during the year. In future all maps of this series will be engraved; the series in time will supersede the Map of India and Adjacent Countries, scale 32 miles to 1 inch, the layered edition of which was republished during the year.

(f) **Geographical Maps on smaller scales.**—The new map of India on the 1:4,000,000 scale, to replace the 64 miles to 1 inch map has been held up owing to various causes, but the engraved plates are now practically ready and it is hoped to publish the map in 1919.

The plates of the other smaller scale maps maintained by the department have been corrected and kept up to date as far as possible.

The annual edition of the Railway Administration map was also published and the map of the Province of Bihār and Orissa was republished on scale 1 inch = 16 miles.

(g) **Special maps.**—Numerous special maps have been prepared for the General Staff, for Local Governments and other departments as well as a few for private individuals.

49. Map Record and Issue Office.—The total number of printed maps received from the Calcutta Printing Offices (incuding the Engraving Office) was 998,604 of which the face value amounted to Rs. 5,61,287. Details are given in Table IV. The number of maps printed at the Trigonometrical Survey Office, Dehra Dūn and received in this office was 8,204 of which the face value amounted to Rs. 7,692.

The total number of printed maps issued from this office was 883,543 of which the face value amounted to Rs. 2,88,038.

The details are as follows:—

	Government Officials.	*India Office.*	*Departmental Issues.*	*Private Individuals.*	*Map Agents.*	**Totals for 1917-18.**	*Totals for 1916-17.*
No. of maps	795,810	4,392	34,791	42,464	6,086	**883,543**	685,206
Value Rs.	2,12,861	5,981	29,814	33,276	6,106	**2,88,038**	3,44,398

The number of maps issued during the year shows a considerable increase even over the issues of 1916-1917; this increase however continues to be very largely due to ever growing demands of the Army, for whom a special reduction of 50% off the face value of maps has been made. The improvement in the sale of maps to private individuals and map agents which was noted last year continues. Arrangements for advertising the sale of maps have been started, in accordance with the orders of the Government of India, with a view to bring to the notice of the general public the fact that increasingly large numbers of modern maps are being published yearly and are available.

The new system of card-indexing receipts of maps in the *Print Section* of the Office, which was started during the year under report, has been completed; but it has been found necessary to extend this system to cover issues of maps from the Section. It is also hoped to extend the same system to the records in the *Original Section* in the near future.

The building of new racks for maps in the remaining map store rooms has been stopped owing to the decision to remove the Calcutta Offices to Dehra.

50. No. 1 (Head Quarters) Drawing Office.—*Compilation Section.* The preparation of the fair sheets of one of the 1:1,000,000 scale India and Adjacent Countries series has been under fair-drawing and the compilation of two other sheets of the same series has been in hand during the year under review.

Patterns for three new engraved sheets of the 1:1,000,000 scale India and Adjacent Countries series have been completed in full and supplied to the Engraving Office; while patterns have been partly supplied or are in hand for three other new engraved sheets and for three second editions of engraved sheets of the same series previously published.

Now that town and village sites and the size and style of lettering of all place names are classified to distinguish both their administrative importance and their population, certain engraved sheets of the 1:1,000,000 scale India and Adjacent Countries series have to be altered in accordance with this new classification, brought up to date and modernized for re-engraving. Patterns of four such sheets have been completed in full and supplied to the Engraving Office.

Patterns have also been completed and supplied to the Engraving Office for four new sheets of the 1:1,000,000 scale International series while for four other sheets of the same series layer guides have also been completed and supplied.

For the 1:2,000,000 scale Southern Asia series some of the outline patterns have been prepared.

It has now been decided to engrave all the sheets of this series for which the Head Quarter Offices are responsible, so patterns are accordingly being prepared for engraving two other sheets which were previously being fair-drawn for reproduction by heliozincography.

For the new 1:4,000,000 scale engraved map of India colour guides and patterns for hill and range names have been completed.

Miscellaneous work includes the drawing of fair sheets of four new Town Guide maps of which two have been reproduced experimentally and the corrections found necessary for this new style of mapping are being carried out on all the fair sheets before final publication.

Hill-shaded originals have also been prepared for twelve maps on various scales.

Half-Inch and Quarter-Inch Section.—Fair sheets of three new half-inch sheets have been completed and sent to press. The fair sheets of all the old half-inch Sind Survey sheets have been cut up and "masked" for publication in 14 modern style half-inch sheets ("Preliminary Editions"). These fair sheets are only waiting for final corrections in certain particulars, which the Local Government has been asked to supply, before being completed and sent to press.

Fair sheets of two quarter-inch sheets have been drawn and sent to press for publication as "Preliminary Editions." Fair sheets of six other quarter-inch sheets (for publication as "Preliminary Editions") and of three quarter-inch sheets (for publicaion as "Provisional Issues") are in hand.

Mapping and Reprint Sections.—Fair sheets of 227 published maps (95 for general stock and 132 for special stock) on various scales have been corrected and brought up to date for reprint as against a total of 136 maps in 1916-1917.

Fair sheets of 185 maps on various scales, drawn by field parties or by other drawing offices, have also been corrected before final publication.

Of the quarter-inch sheets prepared from Atlas or other old quarter-inch material for publication as "Provisional Issues," the fair sheets of 25 sheets have been completed and sent to press, while 31 sheets are in hand; as

against the totals for 1916-1917 of 35 and 22 sheets respectively. Fair sheets of four new Provincial maps on various scales have been completed and sent to press.

A considerable amount of extra-departmental work has been carried out as usual for the Army, other Government departments and semi-official concerns. Such work includes the preparation of fair sheets for three new maps to illustrate the report of the Calcutta University Commission, for a new 80-mile railway map for the "Indian Bradshaw", for 26 special District maps to illustrate the progress of dacoity in Bengal, &c.; the usual annual revision of the fair sheets of the 64-mile Railway Map of India with corrections to March 1918; the revision of fair sheets for the 180-mile map of India illustrating statistics of co-operative credit societies and for the 128-mile map of India showing provincial head-quarters of the Dufferin Fund, &c., &c.

Office Copy Section. Corrections and additions received from various local authorities have been recorded on the office copies of 3,022 published departmental maps on various scales for incorporation in future reprints of such maps. Office copies of 569 new departmental maps have been prepared for maintaining a similar record, and colour guides for boundaries, &c., have been prepared for 578 new maps.

Miscellaneous work includes the checking and recording of areas contained in one-inch and half-inch maps received in the Headquarter offices for publication, supplying copies of original records to Government officials on demand and to private applicants on payment, and dealing with questions concerning Revenue Survey maps.

Examining Section. 521 cases have been examined and passed as against a total of 420 cases in 1916-1917.

A very considerable amount of miscellaneous work on a variety of subjects connected with the examination of maps has also been dealt with.

51. Engraving Office.—The majority of the engravers have continued to be employed on engraving the 1:1,000,000 scale India and Adjacent Countries series and the International series of maps on the same scale.

All the plates of four new sheets of the 1:1,000,000 scale India and Adjacent Countries series and of three new sheets of the International series have been completed, and three sheets of the former series which were previously published as engraved editions have been brought up to date, modernized and the new plates engraved.

Work in hand at the end of the year under report comprises two new sheets of the 1:1,000,000 scale India and Adjacent Countries series, four new sheets of the 1:1,000,000 scale International series, and one modernized sheet of the former series. The plates of most of these sheets are nearing completion.

Of the 1:2,000,000 scale Southern Asia series, the plates of two sheets have been projected and portions of the outline have been drawn on them from patterns supplied by No. 1 Drawing Office. Further work on these plates has had to be suspended temporarily pending a decision as to the size and style of lettering to be used for the smaller place names on all the engraved sheets of this series.

Engraving of all the plates of each of the four sheets of the new 1:4,000,000 scale map of India was completed during February 1918, but further corrections to that part of this new map covered by the new Himālayan Map are awaited from No. 2 Drawing Office before the

plates can be finally completed and transfers supplied to the Photo.-Litho. Office.

Periodic corrections have been carried out on the plates of all the small scale maps of India, of District maps and of Index Charts; and, in addition, new plates have been engraved for three new District maps and the new 192-mile Index maps of Half-inch and Quarter-inch sheets.

Extra-departmental work carried out includes the engraving of several new plates for different kinds of scales required by the Army, engraving titles on photogravure plates which are prepared in the Photo.-Litho. Office, and various miscellaneous work.

In the *Printing Section* of the office 42,158 impressions were pulled as against 40,148 in 1916-17. Of this total 20,985 impressions were pulled for extra-departmental orders, such as photogravures, commission forms and certificates.

In the *Steel Facing Section* of the office 270 plates were dealt with.

52. Photo.-Litho. Office.—The year 1917-18 has again witnessed a large increase in the demand for maps by the military authorities. This increase has again resulted in the out-turn for the year constituting a record. This increase over the out-turn of 1916-17 was only accomplished by the employment of more overtime as was foreshadowed in this report last year. The employment of two shifts of men on the litho. machines to cope with future increased demands would be inadvisable as it would entail work being carried on by artificial light, which would render it very difficult to ensure the matching and evenness of colours. Two rotary offset machine presses have therefore been indented for from England and it is hoped that, with the help of these, the increased demands for maps may be met.

During the year under report 2,976,929 finished maps and diagrams were printed in the machine presses as against 1,080,573 during 1916-17. On an average less than two printings were required to produce each finished copy as compared with between three and four printings last year. This difference is due to the fact that during 1917-18 a very large number of diagrams in black only were printed as illustrations for various military hand and text books. The highest monthly out-turn was attained in February 1918 when 919,188 completed copies were produced on the machine presses.

Ten litho. machines ran for the whole year; there has therefore been no increase in the utilised machine power.

The fifteen hand presses produced 82,540 impressions against 40,235 in 1916-17.

About 21½% of the total out-turn represented maps printed for the department, while the remaining 78½% was composed of work done for the army and other departments.

The work done for the department includes 97 new and 132 reprint editions of modern style one-inch maps in colours. Preliminary editions of 37 one-inch maps were printed in colours, black and brown, or black only, while *Village Boundary editions* were published of 2 modern one-inch maps. The total number of modern one-inch maps printed or reprinted during the year was 268. Of the *half-inch series* 80 new sheets were printed in colours and 16 were reprinted.

During the year 17 new quarter-inch *degree sheets* were printed, 28 being "Provisional Issues". In addition 142 degree sheets were reprinted either in colours, black and brown, or black.

Of old style sheets 75 were reprinted on the one-inch, and quarter-inch scales.

The *Negative and Powder Process Sections of the Photo. Branch* have turned out 3,968 and 1,781 negatives respectively or a total of 5,749 negatives as against 4,452 produced by the *Negative Section* during 1916-17 before the *Powder Process Section* was formed. The *Retouching Section* dealt with 5,500 negatives as against 4,778 in 1916-17, while the *Helio. and Vandyke Sections* have together turned out 8,426 plates as against 7,496 during 1916-17.

The *Process Engraving Section* during the year prepared 25 photogravure plates, 223 half-tone blocks and 132 line blocks, a total of 380 blocks and plates as against 776 during 1916-17. From the half-tone and line blocks an aggregate of 1,418,321 impressions were pulled compared with 755,324 impressions pulled during last year.

The *Type Printing Section* set up 7,476 pages of matter of which, in all, 942,811 copies were printed, 1,677,147 impressions being pulled.

In regard to methods and processes several improvements have been introduced. A section which has already been mentioned above has been formed to work the "Powder Process" by means of which any number of reversed copies can be made of a negative. Its introduction has improved the quality of the maps, considerably lightened the work of the studio which was rapidly becoming congested, and reduced the cost of reproduction of coloured maps, and but for its introduction it would have been impossible to cope with all the demands for reprints for mobilisation purposes in anything like as short a time as that in which the work was actually carried out.

A very notable economy has been effected by this means, the saving on a whole year's working amounting to about Rs. 12,000.

During the past year Mr. Vandyke has introduced several improvements in the new method of preparing tint plates for layered maps, which was mentioned in this report last year; these improvements all tend towards the simplification of the method and effect a consequent cheapening of the work.

The following tables and diagrams illustrate the steadily increasing work of the office.

Out-turn of Photo.-Litho. Office during 1917-18.

TABLE A.

1	2	3	4	5	6	7
Year.	*Cost of office.	†Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	Number of maps printed.		
				Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*	*Rs.*			
1915-16	1,80,603	3,41,782	63,791	847	2,229	3,076
1916-17	1,79,661	3,47,271	36,009	793	3,391	4,184
1917-18	**2,08,784**	**4,34,124**	**1,01,130**	**817**	**3,812**	**4,629**

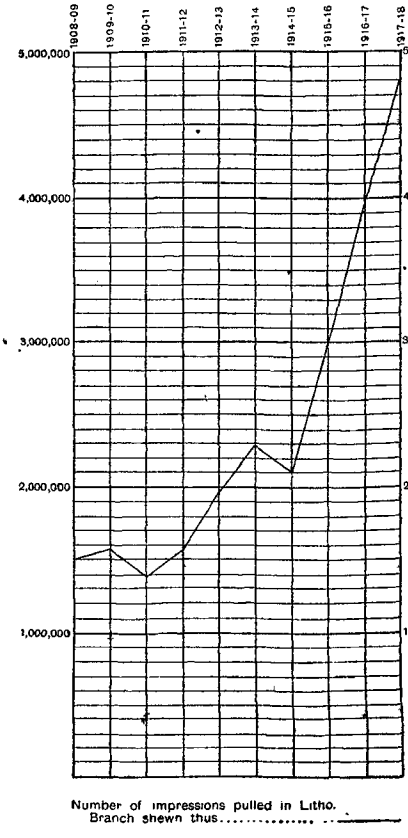
* Does not include cost of chemicals, paper, &c., obtained from England.

† Does not include value of stores, &c., supplied to other departments nor the amount realised from the sale of unserviceable stores.

TABLE B.

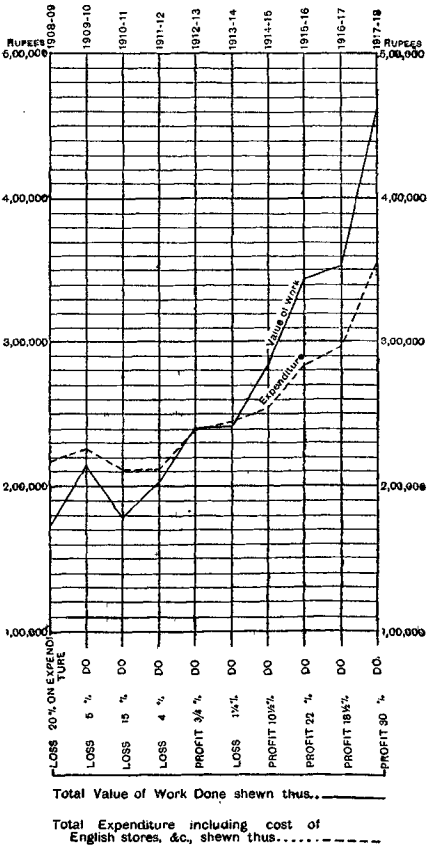
1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	TYPE SECTION OUT-TURN. Pages or items published.	Copies printed.	Impressions pulled.
1915-16	2,975,149	86,373	894,230	5,383	1,143,075	2,053,663
1916-17	3,954,954	5,186	639,838	8,216	1,311,014	2,051,347
1917-18	**4,796,813**	**224,903**	**1,193,418**	**7,476**	**942,811**	**1,677,147**

DIAGRAM SHOWING OUTTURN OF THE LITHO. BRANCH
during the last ten years.



Number of impressions pulled in Litho. Branch shewn thus.....

DIAGRAM SHOWING PROFIT AND LOSS
on the working of the whole office
during the last ten years.



Total Value of Work Done shewn thus.....

Total Expenditure including cost of English stores, &c., shewn thus.....

53. Mathematical Instrument Office.—During the year from 1st April 1917 to 31st March 1918, there was an increase in the demands made on this office (*vide* item 1 in para. 2) as well as in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 1,55,859 and Rs. 50,741 against a profit of Rs. 69,785 and Rs. 44,439 in 1916-17.

2. Below are given the usual comparative figures for the last 3 years :—

	1915-16.	1916-17.	1917-18.
	Rs.	*Rs.*	**Rs.**
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	2,51,818	5,52,655	**8,88,658**
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	52,535	58,423	**53,133**
3. Value of instruments received from Government Officers when no longer required.	54,411	77,147	**85,209**
4. Book value of the stock of instruments, &c., in Serviceable Stores.	5,68,631	4,73,155	**3,92,268**
5. Book value of the stock of instruments, &c., in Repairable Stores.	70,896	1,15,805	**1,04,394**
6. Total value of work done in the Workshop ...	1,96,704	2,99,531	**3,41,627**
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	71,641	1,76,119	**1,85,737**
8. Value of instruments purchased locally ...	11,255	1,09,039	**4,30,336**
9. Value of instruments and materials obtained from England through the Director General of Stores.	1,69,073	1,01,744	**66,380**
10. Average No. of employees and their pay ...	No. * 404 Rs. 91,654	No. * 417 Rs. 1,02,664	**No. 504 Rs. 1,33,719**

* Incorrectly given as 337 and 353 in the General Report for 1916-17.

3. During the year the stock of all the three stores, (the Serviceable, the Repairable and the Material Stores), was twice taken with one exception and the discrepancies noticed have been adjusted. The exception being the wood godown the stock of which could only be once taken.

Table IV.—Departmental Publications, Calcutta, 1917-18.

Note.—For special publications at Dehra Dun, *vide*, pages 34 to 37.

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	Reprints and New Editions.		
GEOGRAPHICAL MAPS.					*Rs.*
Maps of India	Various	1	4	6,265	6,445
Southern Asia Series	1:2,000,000	.....	4	5,920	17,760
India and Adjacent Countries ...	1:1,000,000	2	25	28,756	28,756
Do. (International Series) ...	1:1,000,000	1	1	500	500
TOPOGRAPHICAL MAPS.					
DEGREE SHEET SERIES.					
Modern	1 -4 miles	17	134	1,82,160	1,82,160
From Atlas or other old Material .	Do.	28	8	10,354	10,204
HALF-INCH SERIES.					
Modern	1"-2 miles	80	16	68,860	68,860
ONE-INCH SERIES.					
Modern	1"-1 mile	97	132	90,856	88,888
Do. (Preliminary Editions) ...	Do.	28	9	18,360	18,360
Do. (Village Boundary Editions)	Do.	.....	2	200	400
Old Style Sheets	Various	.....	67	17,855	26,492
MISCELLANEOUS.					
Atlas of India Series	1"-4 miles	.....	19	1,150	1,151
Provincial Maps	Various	2	3	2,230	2,554
District Maps	1"-4 miles	.....	4	1,400	1,500
Administration Report Maps ...	1"-8 miles to 1"-16 miles	3	57	3,250	1,219
Plans of Cities and Cantonments ...	Various	.....	2	700	650
Index Maps	Do.	4	65	1,16,762	29,241
Miscellaneous Maps	Do.	297	76	4,43,026	76,147
Totals for 1917-18	.....	**560**	**628**	**998,604**	**5,61,287**
Corresponding totals for 1916-17..	... .	761	593	686,133	*5,09,155*

LETTERPRESS.

1. Survey of India. General Report. 1916-17. . *Price Rs. 2 or 2s-8d*
2. Topo. Hand-Book. Chapter XI. Geographical Maps, 1917. *Price As. 4 or 4d.*
3. Index to names appearing on Million sheet No. 10, 1917. *Price As. 2 or 2d.*

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

54. Computing Office.—During the year the adjustment of minor stations and intersected points of the following Geodetic Series was carried out:—

(1) Assam Longitudinal,
(2) Assam Valley,
(3) Nāgā Hills,
(4) Kohīmā,
(5) Manipur Longitudinal,
(6) Manipur Meridional,
(7) Mandalay Longitudinal,
(8) Mandalay Meridional,
(9) Khāsi Hills, and
(10) Jaintiā Hills.

In addition the adjustment of the Akā Triangulation and the pendent portion of the Assam Valley Series was completed. Corrections were applied to latitudes, longitudes, azimuths and log. sides of triangulation falling in some 40 Burma Degree Sheets, the pamphlets of which have been sent to press.

Further computations in connection with Professional Paper No. 16 and the Auxiliary Tables, part II, 5th Edition, were effected during the year. Computations of the humidity corrections to height deductions and of the Hayford reduction for gravity determinations were also carried out.

The adjustment of lines of levelling in hand last year and of the relevelled portion of old line No. 64 (Bareilly to Meerut) was completed. The Levelling Pamphlets for Degree Sheets 53 and 57 were brought up to date and corrected for publication as new editions.

The list of protected stations of the Indian Triangulation referred to in last year's report had to be postponed owing to lack of personnel.

Requisitions for data were received from 25 departmental and non-departmental officials. In many cases it was necessary to extract the required information from manuscript records—a work of some magnitude as the data required were sometimes very extensive, especially for areas in Burma.

It is hoped that with the publication of the Burma Triangulation Pamphlets the business of abstracting data from manuscript records will be greatly reduced.

A large number of requisitions for forms were complied with.

115 "Degree Sheet" Triangulation Pamphlets were compiled and compared during the year and fair progress was made in the assembly of triangulation data for areas adjacent to India, in Persia and Baluchistān. 75 Triangulation Pamphlets were published and 87 pamphlets, including last year's undistributed pamphlets, were distributed.

Editions of Levelling Pamphlets Nos. 85 and 92; Professional Paper No: 16, Records of the Survey of India, Vol. XI; and Tide Tables for the Port of Basrah, 1919, were bound and distributed.

Type Printing Section.—The following publications were printed during the year:—

(1) 75 Triangulation Pamphlets,
(2) Levelling Pamphlets 84, 85 and 92,
(3) Tide Tables for the Port of Basrah, 1919,
(4) Professional Paper No. 16,
(5) Records of the Survey of India, Vol. XI,
(6) Auxiliary Tables of the Survey of India, 5th Edition, Part II (Mathematical Tables),
(7) Pamphlet on the transliteration of place names.

Observatories.—Meteorological observations were continued as usual. The Omori Seismograph has been working satisfactorily throughout the year. Tremors of considerable intensity were recorded on the 15th August and on the 7th September 1918.

Photographs of the sun were taken on 348 days the sun being obscured on the remaining days of the year.

Preservation of Trigonometrical Stations.—1,013 stations were repaired by district officers at a cost of Rs. 4,564-2-3. Out of 359 districts from which reports were due, 11 failed to make returns.

55. No. 2 (Dehra) Drawing Office.—*During the year under* report the work in this office was carried out by four sections.

(1) *The Triangulation Chart and Cantonment Plan Section.*—In addition to ordinary and miscellaneous work 9 one-inch sheets of Tehri-Garhwāl were mapped and published and a map of Peshāwar City on the scale of 1 inch to 6 miles was drawn. 91 sheets of seven different cantonments were coloured.

(2) *The Compilation Section.*—The rough compilation on the 12-mile scale of only one sheet of the area allotted to No. 2 Drawing Office, up to East Longitude 104°, remains in hand; 4 sheets have been sent to the Superintendent, Map Publication, for publication, and the fair-mapping of the remaining 10 sheets is in progress. The compilation of the northern half of the Brahmaputra Sheet of the Southern Asia Series has been taken up. The fair-mapping of the Himālayan Map on the scale of $\frac{1}{3\,M}$ is in progress.

(3) *The Stein Section.*—The fair-mapping of the sheets comprising Sir Aurel Stein's explorations in 1900-01, 1906—08 and 1913—1915 has been continued. 16 sheets have been sent to press; 17 sheets have been completed and are awaiting Sir Aurel Stein's approval and 14 sheets remain in hand.

(4) *The Half-inch Section.*—The ½-inch sheet remaining in hand last year, namely, $53^{L}_{S.E.}$ was completed and published. The fair-mapping of the Mesopotamian sheets was commenced, but it was taken over by the Deputy Director of Surveys, Mesopotamia, during the year, and this section has again taken up the preparation of ½-inch sheets of which 4 are in progress, namely:—$63^{F}_{N.W., N.E., S.W., S.E.}$

Three sheets on the 1:1,000,000 scale of South-West Arabia, namely, those named, 'Asīr, Yaman and Hadhramaut, respectively, have been published.

The following is a summary of the work of the office during the year 1917-18 :—

Class of map.	Sheets sent for publication.	Sheets remaining in hand.	REMARKS.
Geographical maps, scale $\frac{1}{M}$ (Fair sheets)	7	10	
Geographical maps, scale $\frac{1}{M}$ (Rough compilation)	.....	3	
Geographical maps, scale $\frac{1}{3M}$ (Fair sheets)	.....	4	Himālayan map.
ographical maps, scale $\frac{1}{2M}$ (Rough compilation)	.....	1	Brahmaputra sheet.
Sir Aurel Stein's exploration in Chinese Turkistān and Kansu in 1900-01, 1906—08 and 1913—15, for publication on $\frac{2}{M}$ scale	16	31	
Degree Triangulation Charts, scale 1 inch to 4 miles	64	17	
Miscellaneous maps	2	.....	
Cantonment plans (corrections for 1917) ...	125*	.....	*Corrections to originals of 44 Cantonments.
Cantonment plans (corrections for 1918) ..	21†	64	†Corrections to originals of 6 Cantonments completed, 32 Cantonments in hand.
Cantonment plans (colour guides) ..	91‡	.....	‡Colour guides prepared for 7 Cantonments.
Half-inch sheets	1	4	
Miscellaneous Extra-departmental maps ...	14	2	
Levelling Charts, scale $\frac{1}{M}$	3	.....	
Index Charts	4	.....	

Photo.-Zinco. Section.—During the year 1917-18 the work undertaken comprised :—

Cantonment Maps.
Triangulation Charts.
Forest Maps.
Extra-departmental Maps.
Maps of Arabia.

In the year under review the smaller of the two litho.-printing machines was dismantled and sent to Baghdad and Mr. C. F. Oddy, Zincographer, was deputed to accompany and re-erect it.

Four technical hands were lent to the Deputy Director of Surveys, Mesopotamia Expeditionary Force.

The "Powder process" for producing duplicates of negatives was introduced and very satisfactory results are being obtained.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Cyanotype prints.
1915-16 ...	2,065	1,717	307,357	1,209
1916-17 ...	1,302	1,600	287,514	571
1917-18 ...	**1,130**	**1,719**	**345,776**	**127**

56. Forest Map Office.—The work of this Office is performed by four sections as follows:—

(*i*) *The Drawing Section*, which prepares original drawings for reproduction, these fall into six classes, *viz:*—

(*a*) Reprints of Forest maps with corrections to date of issue.

(*b*) Forest editions on the two-inch scale of modern one-inch sheets.

(*c*) Maps of Forest Circles and Divisions.

(*d*) Special maps to illustrate working plans, &c.

(*e*) Maps and diagrams to illustrate administration reports, &c.

(*f*) Maps from special surveys, mostly on the four-inch scale.

The progress of this section for the year under report is shown in the table below:—

Class of map.	In hand on 1st October 1917.	Received during the year 1917-18.	Drawn and sent for publication during the year 1917-18.	In hand on 30th September 1918.	Published during the year 1917-18.
(*a*) ...	103	.....	88	15	58
(*b*) ...	104	20	53	71	48
(*c*) ...	30	4	14	20	21
(*d*) ...	16	23	30	9	23
(*e*) ...	14	1	11	4	10
(*f*) ...	.....	87	43	44	39
TOTALS ...	267	135	239	163	199

(*ii*) *The Portfolio Section*, in which all changes in forest boundaries are recorded on a set of maps specially kept for the purpose; this section prepared portfolio copies of 1,509 maps and carried out 972 corrections to forest maps during the year; 3,807 maps were also coloured by hand.

(*iii*) *The Map Record Section*, which is responsible for the storage and issue of maps and records. The number of maps, &c. received for storage was 24,357; and 20,173 maps, lists, and diagrams, valued at Rs. 25,283, were issued during the year; these figures show an increase of 4,150 maps, &c. and Rs. 1,877 over those for last year. The net amount realized by sales to the public of 1,375 maps was Rs. 2,025; an increase of 706 maps and Rs. 987 over the sales for last year. Book transfer sales to Government officers amounted to 9,086 maps valued at Rs. 9,449; an increase of 6,911 maps and Rs. 7,233 over the figures for last year.

In addition to the above, 1,587 traces, reductions, &c. of 179 sheets were supplied to the Survey of India.

(*iv*) *The Book-Binding Section*, which was formed in January to deal especially with work for the Forest Research Institute; 138 volumes were bound during the year at a cost of Rs. 365.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

57. No. 3 Drawing Office (Northern Circle).—During the year under report 30 one-inch sheets, out of the 67 previously surveyed, were drawn by parties and submitted for publication. In addition to these 3 one-inch sheets were brought up to date and completed to margin in the drawing office, while 3 other one-inch sheets were brought up to date, for purposes of reprint.

The proofs and colour patterns of 58 one-inch and half-inch sheets were prepared and returned to the Superintendent, Map Publication, leaving a balance of 13 colour patterns still in hand.

Half-inch sheets compiled from modern one-inch and old style half-inch maps. 11 half-inch sheets drawn in the Circle drawing office and 13 in the parties were submitted for publication during the year.

On the basis of the one-inch sheets published to 30th September 1918, there now remain for completion in the Northern Circle 145 half-inch sheets of the kind under consideration. Of this number the fair-mapping of 12 sheets is in hand in the drawing office and parties and the material for the preparation of 18 more is held in reserve for future requirements.

Quarter-inch sheets compiled from one-inch and half-inch maps.—During the year two quarter-inch sheets were fair-mapped in the Circle drawing office and submitted for publication. Three others were brought up to date for reprint purposes and returned to the Superintendent, Map Publication.

The colour patterns and layer guides of two quarter-inch sheets were also prepared and sent to the Superintendent, Map Publication.

Royal Artillery Practice and Aviation Maps.—Five Artillery Practice Camp maps and one Aviation map, were fair-mapped in the drawing office and parties and submitted to the Superintendent, Map Publication, with the colour patterns of the Royal Artillery Practice Camp maps.

Hill-shaded sheets.—The hill-shaded sheets of 38 maps on various scales were sent for publication during the year.

Special maps.—The Delhi and Vicinity map in four sheets on the 4-inch scale, which was added to and revised, was submitted for publication.

Miscellaneous.—The traverse plots of stations of 12 *mauzas* consisting of 18 sheets, scale 16 and 32 inches to a mile, of the Gondā district, were prepared for and sent to the Deputy Commissioner, Gondā, at his cost.

58. No. 4 Drawing Office (Southern Circle).—During the year 2 three-inch sheets, 23 one-inch sheets and 3 half-inch sheets, which had been surveyed and fair-mapped by parties, were finally examined and submitted for publication. At the end of the year 2 half-inch sheets, the survey of which was completed during the previous year, had not been submitted.

Half-inch sheets compiled from published sheets of the one-inch map.—10 sheets were fair-mapped and submitted for publication and 9 sheets, which had been fair-mapped by parties, were finally examined and submitted for publication. At the end of the year 9 sheets were being fair-mapped in this office, 24 sheets were being fair-mapped by the parties and every sheet, the component one-inch sheets of which had been published, had been commenced.

Quarter-inch sheets compiled from published sheets of the half-inch map. 2 sheets were fair-mapped and submitted for publication. At the end of the year 6 sheets were being fair-mapped and every sheet, the component half-inch sheets of which had been published, had been commenced.

The examination and the colouring of the proofs of 54 sheets and the hill-shading of 29 sheets were completed and returned to the Superintendent, Map Publication.

A number of pupils were instructed in fair-drawing.

The Photo.-Zinco. Section undertook the photographic and zincographic work required in the circle.

59. No. 5 Drawing Office (Eastern Circle).—During the year 35 one-inch sheets and 3 half-inch sheets, drawn from recent surveys on these scales, were finally received in the drawing office from the parties of the circle as completed for publication. Of these, 26 one-inch sheets and 3 half-inch sheets were forwarded for publication, as well as 6 one-inch sheets which had been received from the parties during the preceding survey year. The remainder are under further correction.

Half-inch sheets compiled from the published sheets of the one-inch map.—The preparation of 14 of these sheets was in hand in the drawing office during the year, and of these, 4 were sent for publication, 6 were received from the parties of the circle, of these 3 were forwarded for publication and 3 still remain to be dealt with in the drawing office.

On the basis of one-inch maps published up to 30th. September 1918, there now remain for drawing in the Eastern Circle 77 half-inch sheets of this kind. Of this number, the fair-mapping of 21 is in hand in the drawing office and parties of the circle.

Quarter-inch sheets compiled from the published sheets of the one-inch and half-inch maps.—7 of these were submitted for publication. Work on 8 others was in progress in the Circle drawing office during the year, while that on 2 others, which had been commenced in No. 11 Party during previous years, remained in abeyance.

Hill-shaded Sheets.—6 of these on the one-inch scale, 17 on that of $\frac{1}{2}$ inch = 1 mile and 8 on that of $\frac{1}{4}$ inch = 1 mile were prepared and sent for publication, leaving in hand in the Circle drawing office a balance, on the three scales together, of 28 awaiting either commencement, completion or final examination.

Layer Guides of 9 quarter-inch sheets were completed and submitted for publication during the year. Work on 2 more had been commenced.

Colour patterns and press order proofs of 37 sheets, on the one-inch, half-inch and quarter-inch scales, were prepared and returned for publication, leaving a balance of 27 one-inch and 7 half-inch sheets in hand and in various stages of completion.

60. No. 6 (Simla) Drawing Office.—As during the previous year this office was organized in 2 sections.

The *Army Section* has dealt with the preparation of maps and plans for the use of the Army in India while the *Survey Section* has been employed on the preparation of trans-frontier maps on the 1:1,000,000, quarter-inch and half-inch scales.

Most of the work of the *Survey Section* has consisted in redrawing in modern style, and sometimes to a reduced scale, the maps already existing, with the incorporation of such additional information of recent date as may have been available.

61. Bengal and Bihār and Orissa Drawing Office.—(*Imperial Standard Mapping Section*). This office, under the direction of the Director of Surveys, Bengal, undertakes the drawing of one-inch sheets from Cadastral surveys and four-inch thāna maps. The former are reduced by pantograph and drawn on the two-inch scale for reduction, the latter are now being drawn on the 1½ inch scale on blue print reductions of the four-inch thāna maps pieced together; this method, which has superseded the old one of making two photographic reductions of the thāna maps before the fair-drawing was put in hand, should improve the out-put in future years.

In both cases the sheets are completed as far as possible by the addition of the hills and other detail from old topographical maps and are published in colours.

In Bihār and Orissa 14 new sheets and 10 new editions of old sheets, formerly published in black, were submitted for publication.

In Bengal 10 new sheets were submitted for publication.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

62. Northern Circle. *No. 1 Party.*—Four Royal Artillery Practice Camps were surveyed on the 3-inch scale of areas as follows:—Akora (near Peshāwar) 103 square miles, Hoshiārpur 61 square miles, and the Yāru and Bostān areas (near Quetta) 143 square miles. The two latter surveys were commenced in June and only completed in September, but the fair maps for Akora and Hoshiārpur have been duly submitted for publication.

No. 2 Party.—Two Royal Artillery Practice Camps on the 3-inch scale. One of 54 square miles south of Delhi (Tughlakābād), and one of 133 square miles in the neighbourhood of Roorkee.

The country surveyed consisted of undulating, cultivated land with low rocky hills devoid of trees in the former area, and in the latter of low-lying cultivated plain intersected by numerous streams from the Siwāliks.

The fair maps of Tughlakābād in one sheet, and of Roorkee in four sheets, have been submitted for publication.

This party traversed a part of the boundary of Chakrātā Cantonment at the cost of the Assistant Commanding Royal Engineer; and surveyors were lent to the Military Works Department at Dera Ismail Khān and Bandar Abbās in connection with road surveys.

No. 3 Party.—One Royal Artillery Practice Camp comprising an area of nearly 31 square miles was surveyed on the 3-inch scale at Kutwa, near Mirzāpur. The fair-mapping has been completed.

Sind-Sāgar Party.—This party executed the whole of the triangulation required for the rectangulation of the "Thal" area of the Sind-Sāgar Doāb, in districts Miānwāli, Shāhpur, Jhang, and Muzaffargarh. The triangulation was based on a few secondary series carried out by No. 15 Party during the same season and covered the whole area of 7,430 square miles. 1,888 stations were temporarily marked by wooden stakes, and from these the corners of the nearest 4,000 acre rectangles will now be laid out.

The country largely consists of rolling sandhills with sparse vegetation. There are scattered patches of cultivation based on wells the water of which is generally brackish.

Punjab Riverain Detachment.—As in previous years this detachment was employed on local surveys in the Punjab. The details of the work done are given on page 17.

63. Southern Circle.—The survey of cantonments and military stations was continued by No. 20 Party. The details of the work are given on pages 17 and 18.

The survey of the Royal Artillery Partice Camps of Aundh, Barelā, Kāpra and Rājankunti was undertaken for the military authorities by Nos. 5, 6 and 8 Parties. The details of the work are given on page 13.

The special survey on the scale of 1½ inches to a mile of reserved forests in the Hyderābād State was continued. No. 6 Party surveyed an area of 409 square miles and triangulated an area of about 1,288 square miles. The cost of the work is being borne by the Nizām's Government.

A surveyor of No. 8 Party was placed on deputation during the field season with the Madras Forest Department to complete the survey of reserved forests on the eight-inch scale in the neighbourhood of Nilambūr in the Malabar district of Madras.

Section VI of the Tinnevelly-Travancore boundary in Madras was identified and traversed by No. 8 Party.

64. Trigonometrical Survey.—The Mayo Salt Mine at Khewra (Punjab), was surveyed by No. 15 Party for the Salt Department, (*vide* page 17). This was a special work not properly belonging to the task of the Survey of India and its cost was defrayed by the Salt Department.

65. Map Publication Offices.—A very large proportion of the work of the Photo.-Litho. Office is for other Government offices, only 21½% of their out-turn this year being departmental, a special feature being the large amount of work done for the General Staff owing to the war. In addition to the usual large number of weather charts, a large number of Treasury Bill forms and about a quarter of a million skeleton border forms for Government Promissory Notes for the Second War Loan were printed. This latter form was designed in the Engraving Office by Mr. T. Chorlton. For the Archæological and other departments photo-gravure and half-tone photographs were also reproduced. The Drawing Office prepared Railway, Manœuvre, Royal Artillery Practice Camp and many other special maps.

66. Mathematical Instrument Office.—The manufacture of heliographs, prismatic compasses Mark VII, scales, protractors, &c., was continued throughout the year. Practically all repair and manufacture work of a civil nature was put aside. Large numbers of metre staves and chains were manufactured and the stock of levels and theodolites was depleted to meet Mesopotamia's demands.

This office also supplied instruments to many Government offices Provincial and Imperial.

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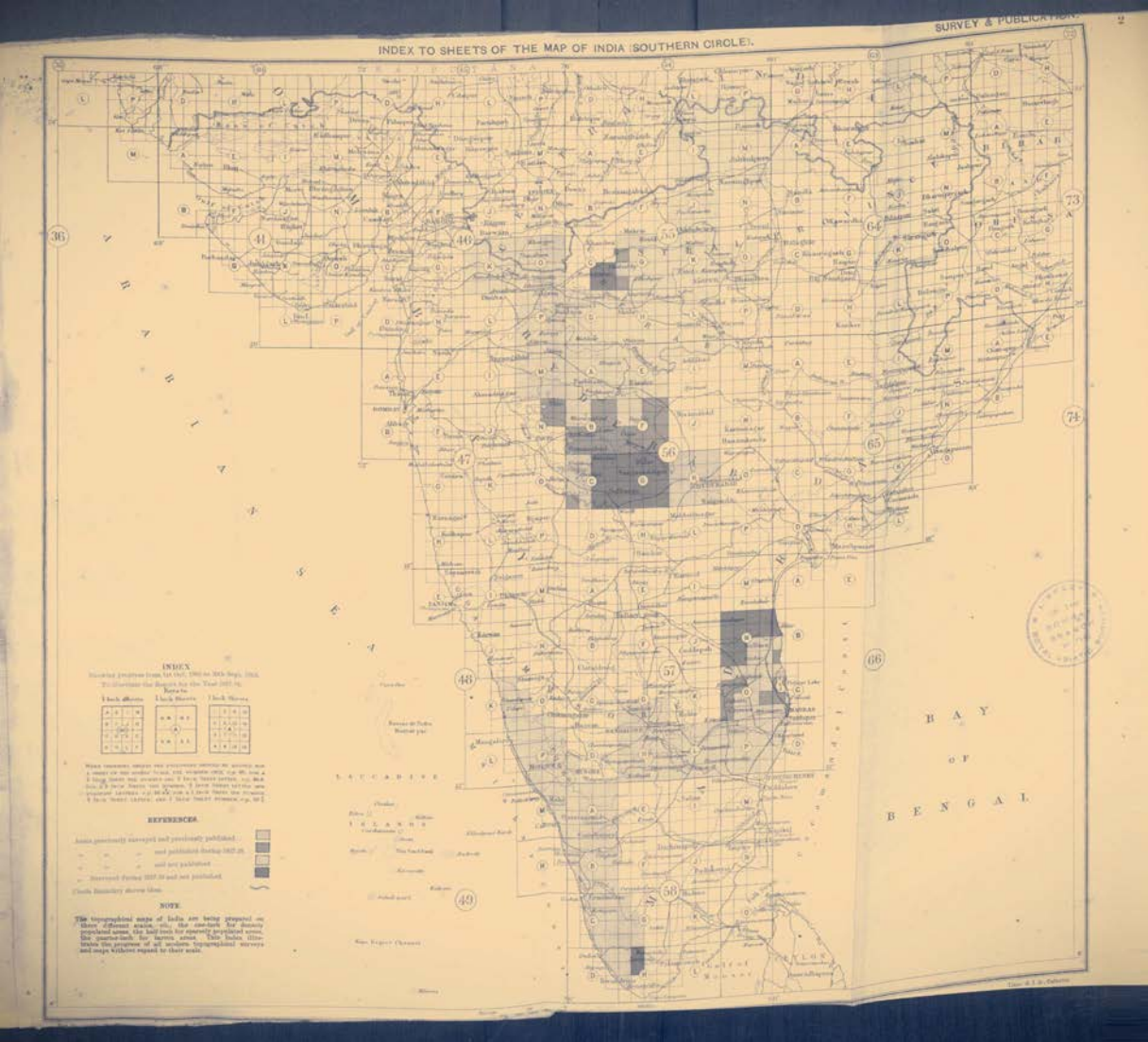
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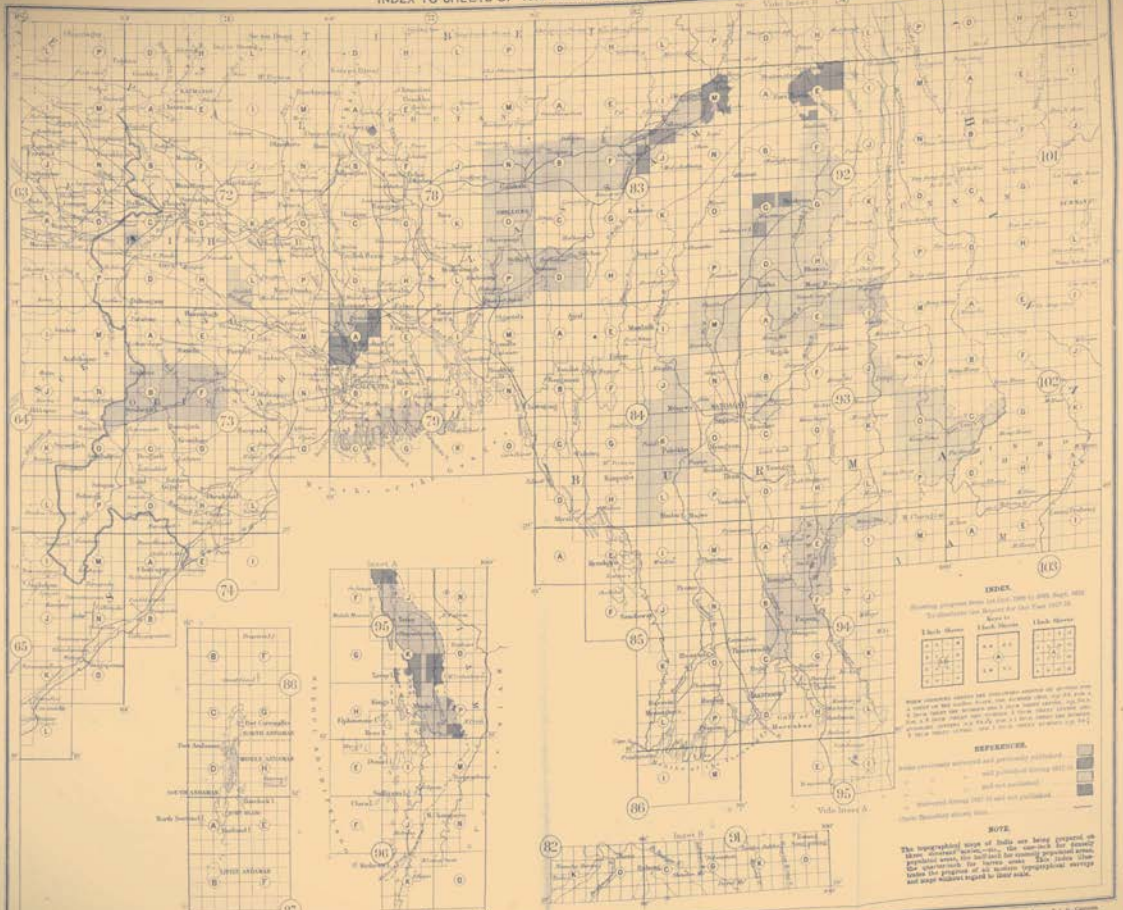
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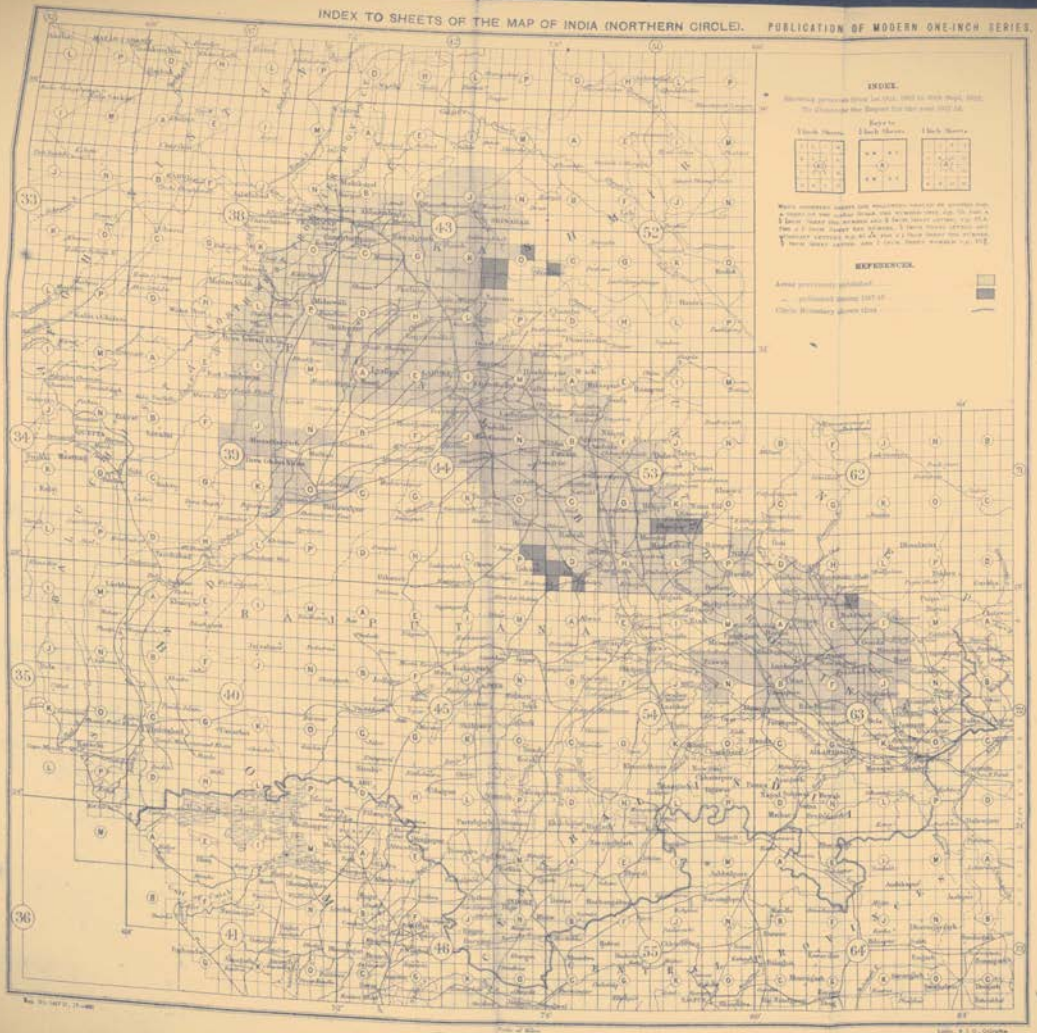
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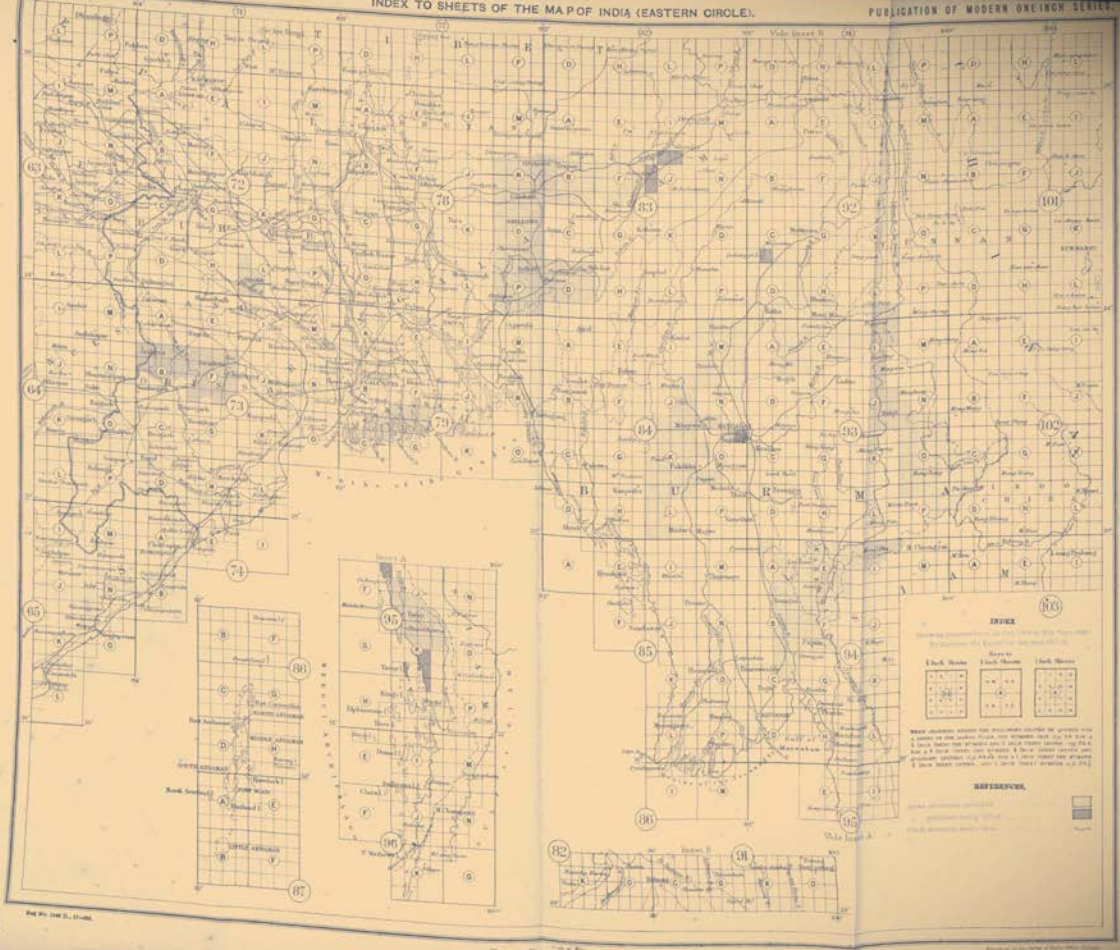

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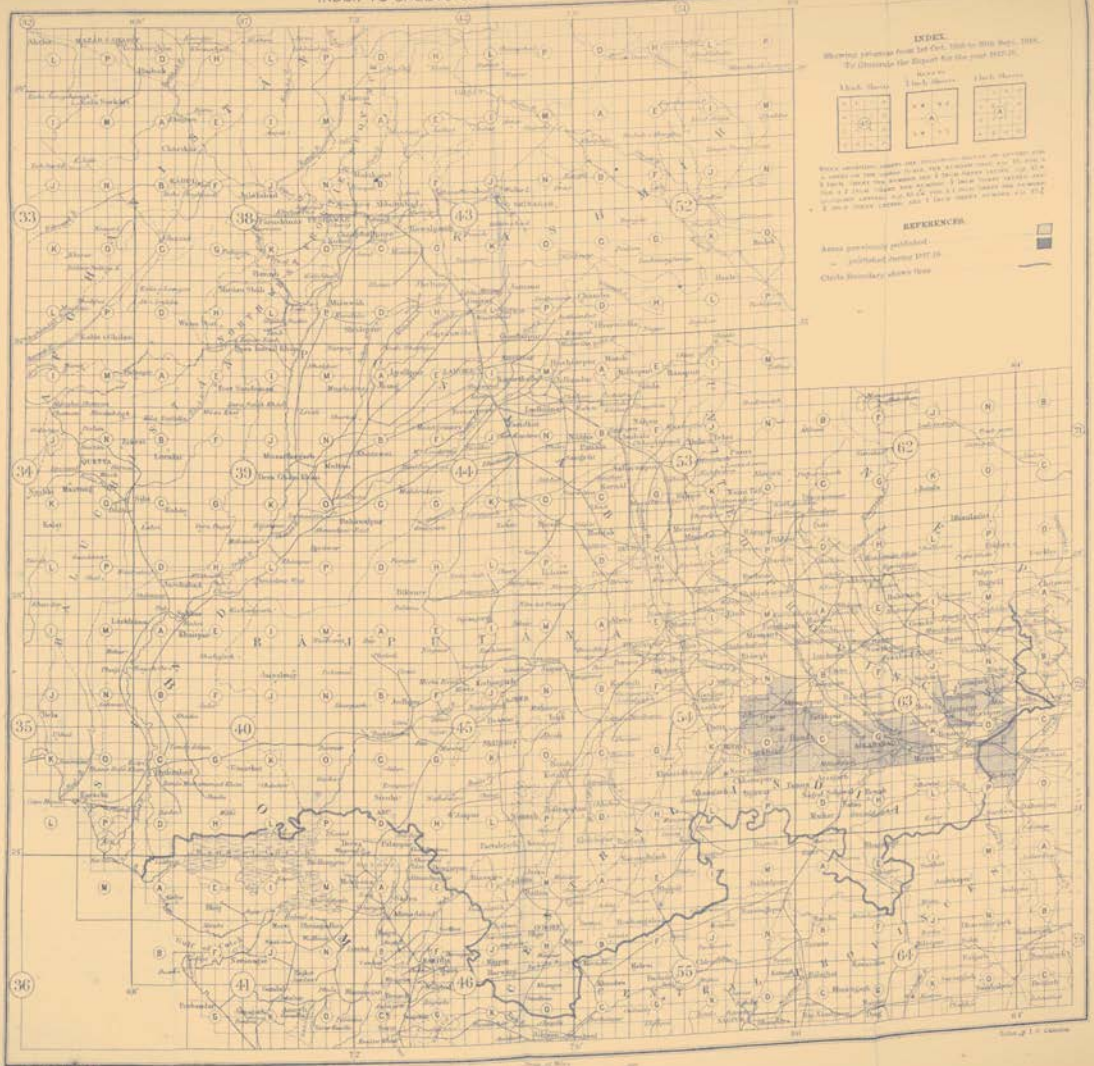

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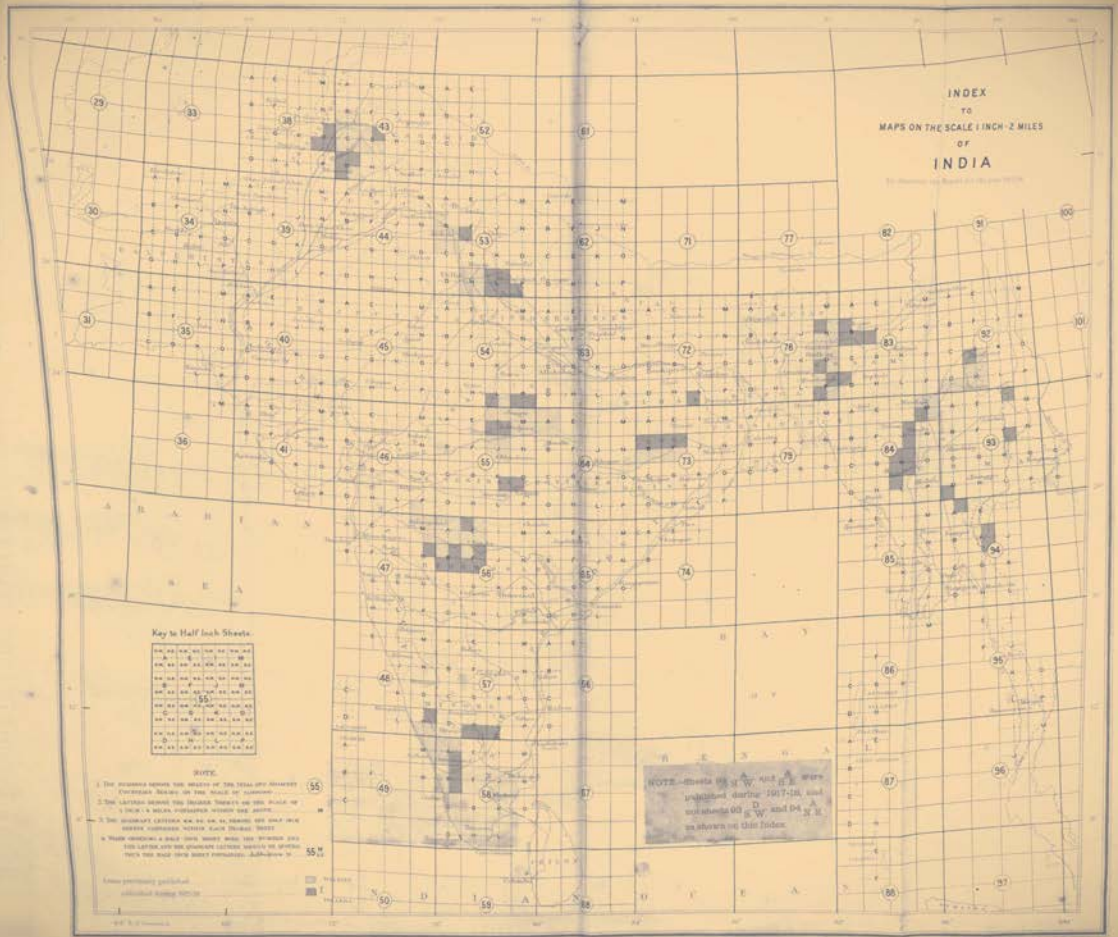
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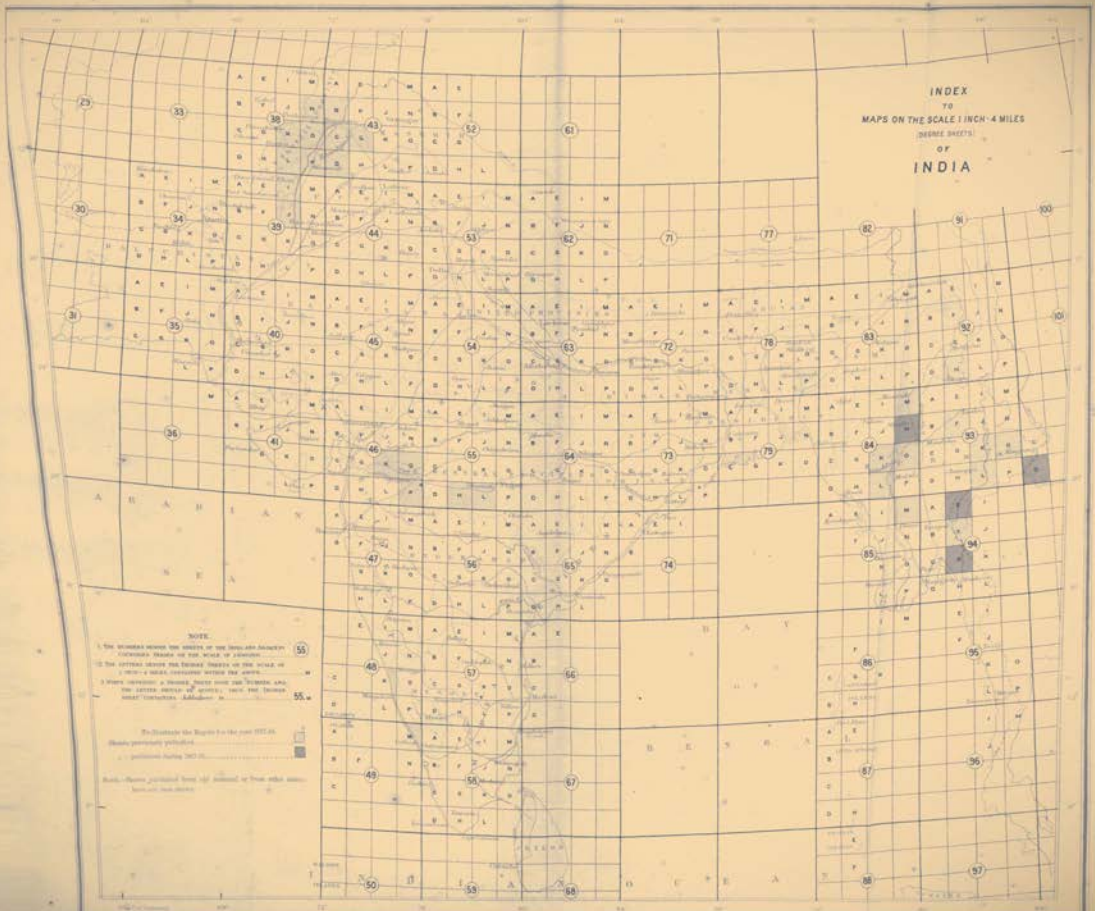
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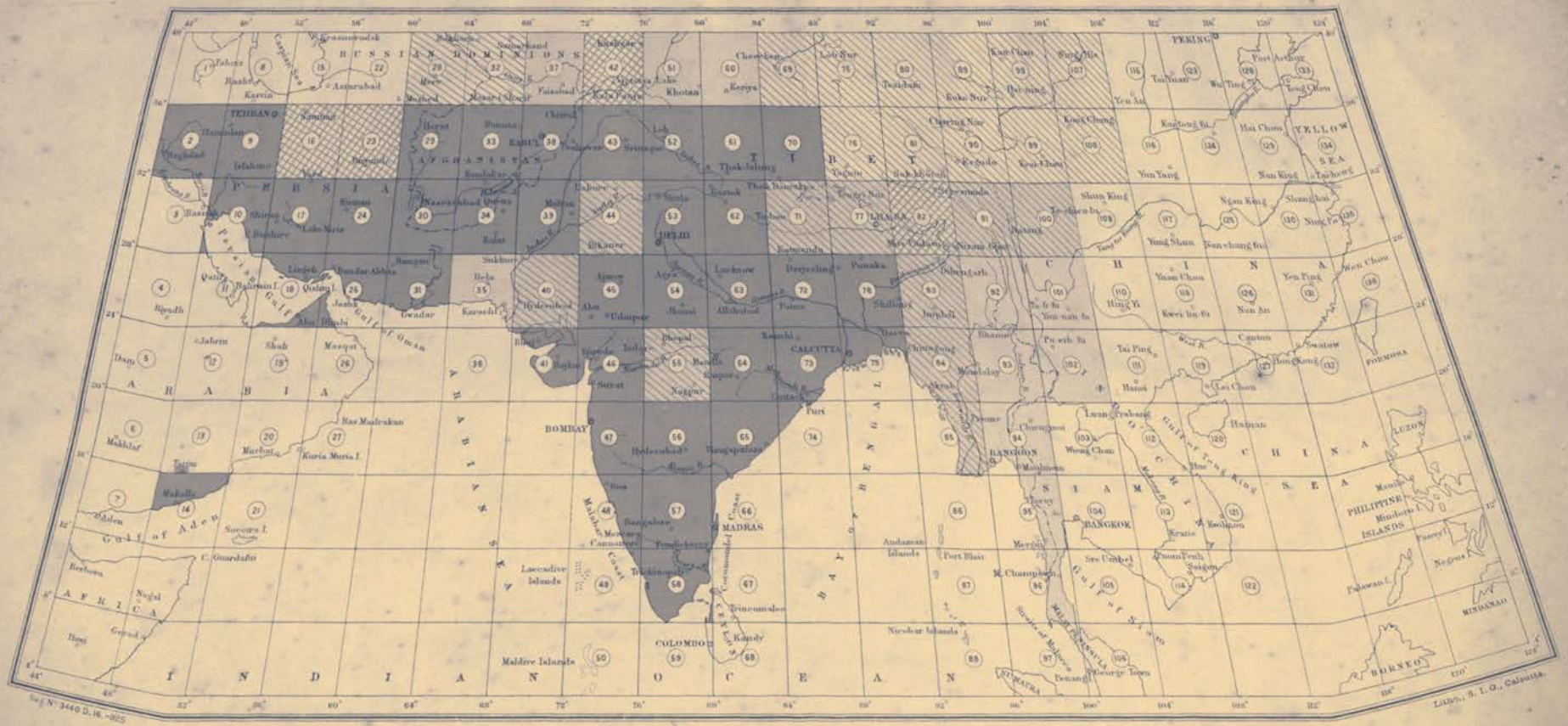
on the Scale of 1:1000,000, or 1·014 inches to 16 miles.



Scale 16 miles to one inch.

Miles 200 0 200 400 600 800 1000 Miles.

REFERENCE

Sheets published without contours & layers.

" " with contours & layers.

" under publication.

" in hand.

To illustrate the Report for the year 1917-18.

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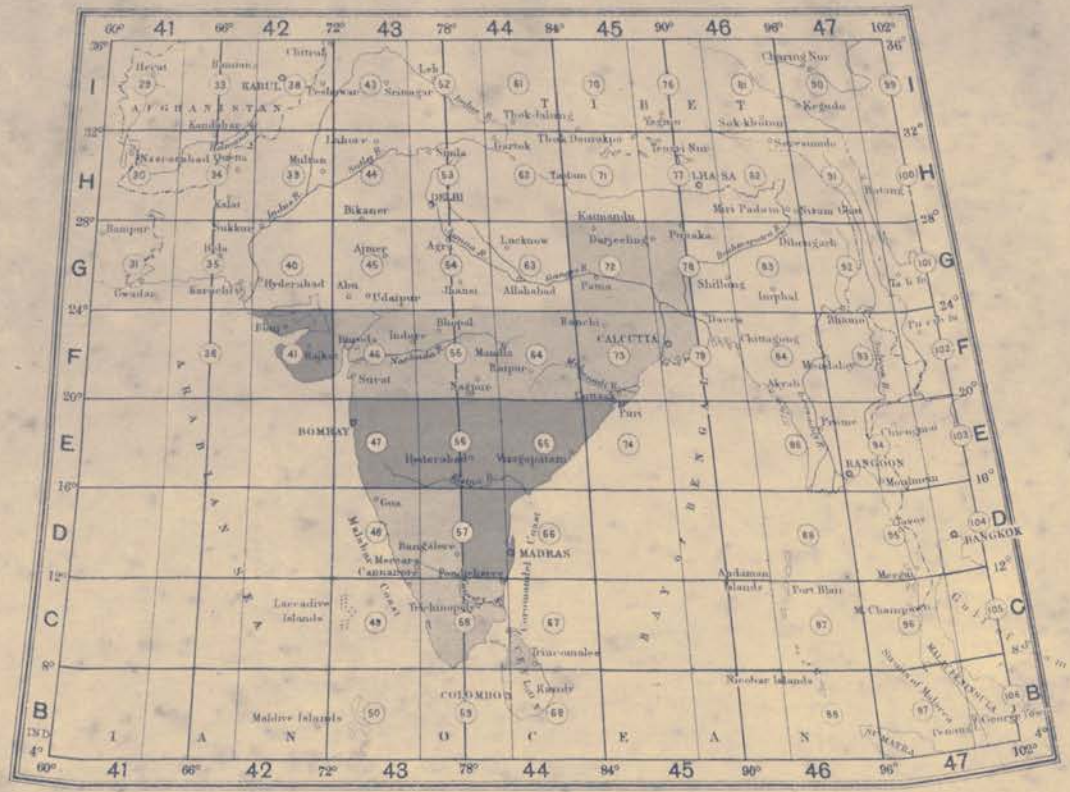

The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter and number corresponding to its position, *e.g.*, the sheet which includes Bombay is N.E-43.

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.

Scale 1/1,000,000.

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REFERENCE.

Sheets published

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" in hand

To illustrate the Report for the year 1917-18.

Litho., S. I. O. Calcutta

Ind. Sc. 3481 D.—16.

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Scale of 1:2,000,000 — about 32 miles = 1 inch

Reg. No. 1442 D., 10.—962.

Printed and published as the Survey of India Office, Calcutta.

Scale 1:10,000,000

Miles 200 0 200 400 600 800 1000 Miles

REFERENCE

Sheets published

Sheets under publication

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To illustrate the Report for the year 1917-18

SOUTHERN ASIA SERIES

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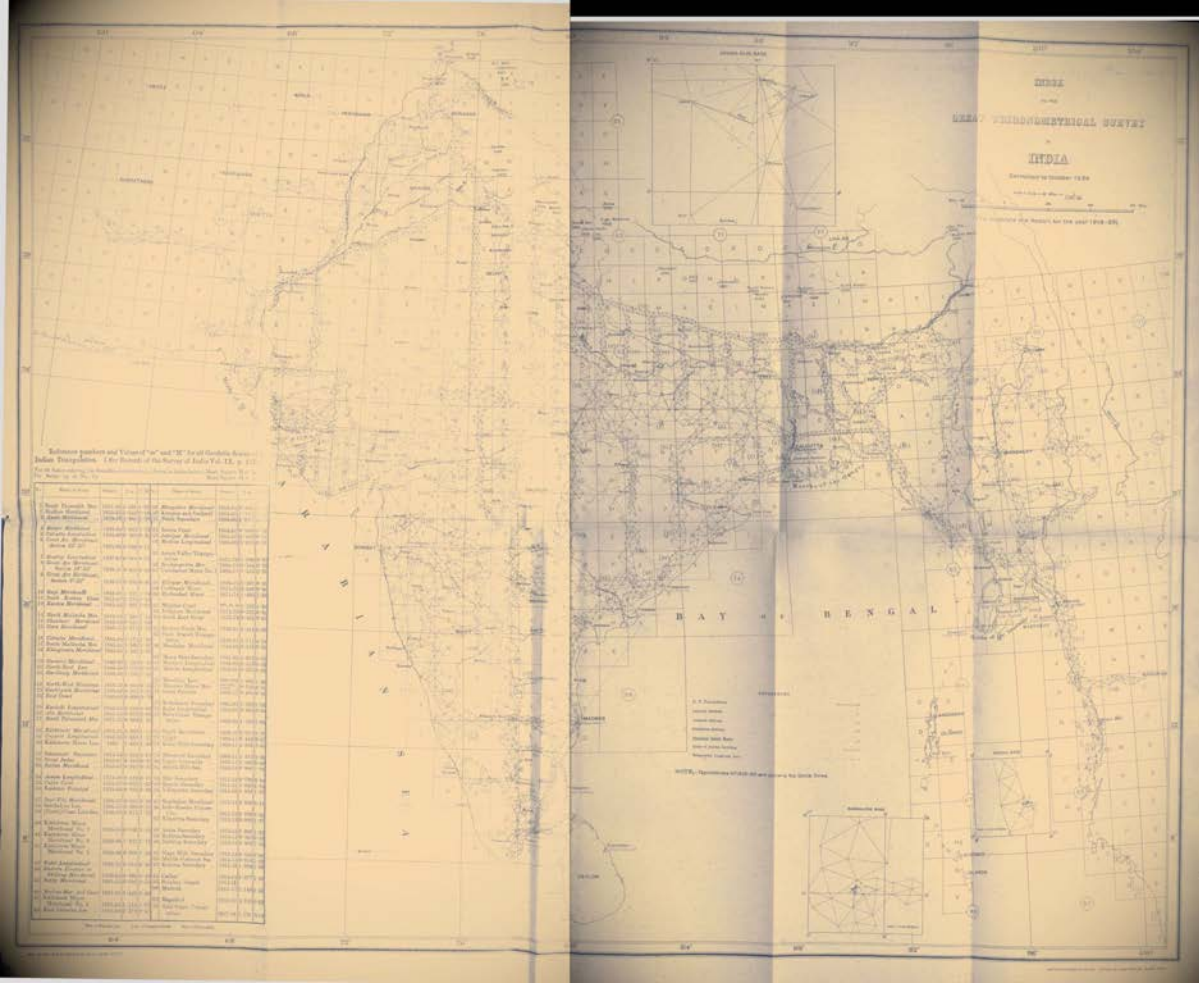
CHART OF THE
GREAT TRIGONOMETRICAL SURVEY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INDIA
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Survey of India.

GENERAL REPORT,

1918–19.

From 1st October 1918
To 30th September 1919.

PREPARED UNDER THE DIRECTION OF

COLONEL C. H. D. RYDER, C.I.E., D.S.O., R.E.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA.

134608

Printed at the
Photographic and Lithographic Office, Survey of India,
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Calcutta.

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7. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
8. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1918—19.

From 1st October 1918
To 30th September 1919.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shown in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XIV of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 10. From this it will be seen that the out-turn of topographical survey during the current year was 13,948* square miles; and that this brings the total progress since 1905 to 510,310 square miles, leaving 1,311,290 square miles still to be done.

3. The first Index map, at the end of the report, shows the progress of this topographical programme both in survey and in publication in the three circles, while the remaining seven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the survey of India is based.

4. Table IV on page 29 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

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*This however excludes 3,738 square miles of revision survey (provisional) on scale of $\frac{1}{2}$ inch=1 mile, and 82 square miles of biennial Delhi revision survey on scale of 4 inches=1 mile.

6. The following events are notified:—

(*a*) Nine Imperial Officers and five Provincial Officers have reverted from temporary military duty. The available strength was not, however, increased, owing to the necessity of granting long deferred leave.

(*b*) Owing to the shortage of officers the field work of the whole department was again considerably curtailed.

(*c*) The Survey party under an Imperial Officer (Deputy Director of Surveys, Mesopotamian Expeditionary Force) which accompanied the field-force in Mesopotamia continued survey operations there.

(*d*) The Survey detachment in charge of a Provincial Officer which was employed on service with the Salonika force returned to India on completion of its work, and was disbanded.

(*e*) The Survey detachment under a Provincial Officer which was despatched to East Africa for duty with Field Survey units of Royal Engineers, returned to India on completion of work, and was disbanded.

(*f*) A Survey party under an Imperial Officer was sent to East Persia in October 1918, to carry out survey operations with the East Persia Cordon Force. The majority of this party returned to India in June 1919, leaving behind a small portion of its personnel from which a separate detachment was formed under a Provincial Officer to complete such extra survey work as might be found to be required by the military authorities.

(*g*) A Survey detachment under a Provincial Officer was despatched to carry out survey operations in the neighbourhood of Būshire (Persia).

(*h*) A Survey party under an Imperial Officer was sent to Peshāwar for duty with the forces operating against the Afghāns.

(*i*) A Survey detachment under a Provincial Officer was sent to Quetta for duty with the forces operating against the Afghāns.

(*j*) A Survey detachment under a Provincial Officer was formed for duty with the Kūki Punitive Force.

(*k*) Lieut.-General Sir W. R. Marshall, K.C.B., K.C.S.I., Commanding-in-Chief, Mesopotamian Expeditionary Force, in his despatch dated the 1st October 1918 wrote as follows:—

"Surveys and the Map Compilation Section have always risen "to the occasion, and have continued to produce a "large output of admirable work".

(*l*) A competitive examination for admission to the Provincial Service was held in July 1919. There were 30 candidates for the five vacancies, which were duly filled.

(*m*) Recruitment for the Upper Subordinate Service has been reopened, and 7 probationers were nominated by the Surveyor General in September 1919.

(*n*) The total number of maps issued continues to show an increase due in part to the operations on the North-West Frontier. The steady increase of issues of maps to private individuals is also noticeable and very satisfactory.

(*o*) There has been a marked increase during the last few years in the demand for surveys on large scales other than for ordinary topographical purposes.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1919 and of the two previous years is shown below:—

	1916-17.	1917-18.	1918-19.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ..	32,93,109	40,33,295	**35,93,116***	*These figures are not final.
Deduct receipts and credits	14,79,255	17,58,796	**17,25,606***	
Net actual cost ...	18,13,854	22,74,499	**18,67,510***	

8. Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., administered the department up to 15th March 1919, except for a month during which he was on leave, Colonel Sir G. P. Lenox-Conyngham, Kt., R.E., F.R.S., officiating for him. Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., administered the department for the remainder of the year.

9. In the Imperial Service Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., retired: Lieutenant-Colonel F. P. Nosworthy, D.S.O., M.C., R.E., was transferred permanently to military duty. The number of Imperial Officers remaining temporarily on military duty on account of the war at the end of the Survey year is 12. Colonel R. A. Wauhope. C.B., C.M.G., C.I.E., R.E., (Retired), vacated his temporary appointment in the department.

Commissary and Honorary Major C. J. Arbery, M.B.E., Officer in charge No. 6 Drawing Office (Simla), has been retained in the service after the age of 55 years. Mr. H. G. Salmond, late R.A.F., has been deputed to this department to assist in experiments in producing maps from aeroplane photographs.

In the Provincial Service Mr. P. R. Anderson died; Captain W. P Hales, I.A.R.O., also died while on active service in Persia. Mr. Syed Aulad Hossein, Khan Bahadur, and Mr. J. A. T. Haddock, the latter of whom was employed under the Government of Burma, retired; Mr. T. W. Babonau was dismissed. Mr. B. M. Berrill has reverted from deputation under the Government of Bombay. The number of officers of the Provincial Service on deputation to military duty at the end of the Survey year is 9.

In the Upper Subordinate Service two officers retired, one of whom, Mr. Lal Singh, Rai Bahadur, was later re-employed; one officer was transferred to foreign service under the Civil Commissioner, Baghdād; one probationer was confirmed and three promotions were made into this service from the Lower Subordinate Service.

The total strength of the department at the close of the Survey year was 44† Imperial Officers, 109‡ Provincial Officers and 52 Upper Subordinates besides specialists, clerks, lower subordinates and menials.

10. A Special Burma Forest Survey Party and a Simla Survey Detachment were formed during the year in addition to the field service parties or detachments already mentioned.

The Punjab Riverain Detachment was raised to the status of a Survey Party.

† Including 12 officers on temporary military duty.

‡ Including 9 officers on temporary military duty, but excluding officers re-employed and on deputation to Local Governments.

11. The following Honours were conferred on members of the department during the year:—

Knighthood.—	Colonel G. P. Lenox-Conyngham, R.E., F.R.S.
Companions of the Distinguished Service Order.—	Major R. H. Thomas, R.E.
	Major H. J. Couchman, M.C., R.E.*
	Major J. D. Campbell, R.E.
Commander of the Order of the British Empire.—	Mr. T. A. Ferrier, Officer in charge, Mathematical Instrument Office.
Officers of the Order of the British Empire.—	Brevet-Lieut.-Colonel C. P. Gunter, R.E.*
	Major M. O'C. Tandy, D.S.O., R.E.
Members of the Order of the British Empire.—	Mr. J. McCraken, Extra Assistant Superintendent.*
	Mr. W. H. Strong, Extra Assistant Superintendent.*
	The late Acting Captain W. P. Hales, I.A.R.O., Extra Assistant Superintendent.
Awarded the Order of St. Anne, 2nd Class, with Swords.—	Brevet-Lieut.-Colonel C. M. Browne, C.M.G., D.S.O., R.E.
Awarded the Order of the White Eagle, 4th Class.—	Brevet-Lieut.-Colonel H. Wood, R.E.*
Promoted to Brevet-Lieutenant-Colonel.—	Major R. H. Phillimore, D.S.O., R.E.
	Major S. W. S. Hamilton, D.S.O., R.E.
Promoted to Brevet-Major.—	Captain C. G. Lewis, R.E.
Mentioned in despatches.—	Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E.
	Lieutenant-Colonel G. A. Beazeley, D.S.O., R.E., (third time).
	Brevet-Lieut.-Colonel H. Wood, R.E., (third time).
	Major H. McC. Cowie, R.E.
	Major E. T. Rich, C.I.E., R.E.
	Major M. O'C. Tandy, D.S.O., R.E., (second time).
	Major R. H. Thomas, D.S.O., R.E.
	Brevet-Lieut.-Colonel R. H. Phillimore, D.S.O., R.E., (twice during the year, once in 1916, altogether thrice).
	Major M. N. MacLeod, D.S.O., M.C., R.E., (second time).
	Major H. J. Couchman, M.C., R.E., (second time).*
	Major J. D. Campbell, R.E.*
	Lieutenant-Colonel F. P. Nosworthy, D.S.O., M.C., R.E., (twice during the year, altogether six times).
	T. Captain H. B. Simons, Extra Assistant Superintendent.
	Mr. D. K. Rennick, Extra Assistant Superintendent.
	Mr. A. J. Booth, Extra Assistant Superintendent, (second time).

* Honour conferred during 1917-18.

Mentioned in despatches (contd.).—	Mr. F. R. Vandyke, Manager, Litho. Section, Photo.-Litho. Office, Calcutta.
	Mr. Jamna Prasad, R.S., Sub-Assistant Superintendent.
	Mr. Hamid Gul, K.S., Sub-Assistant Superintendent, (second time).
	Mr. Annada Prasad Ghosh, Sub-Assistant Superintendent.
	Mr. Laltan Khan, I.D.S.M., Sub-Assistant Superintendent, (third time).
	Mr. Abdul Latif Khan, Sub-Assistant Superintendent.
	Surveyor Muhammad Nasir Khan.
Title of Khan Bahadur.—	Mr. Asmat-ullah Khan, K.S., Extra Assistant Superintendent.
Title of Rai Bahadur.—	Mr. Girindra Nath Mukherji, R.S., Head Clerk, Mathematical Instrument Office, Calcutta.
Title of Khan Sahib.—	Mr. Hamid Gul, Sub-Assistant Superintendent.
Title of Rai Sahib.—	Mr. Nanak Chand Puri, B.A., Sub-Assistant Superintendent.
Awarded the Indian Distinguished Service Medal.—	Mr. Laltan Khan, Sub-Assistant Superintendent.
	Surveyor Ghulam Rasul Khan.
	Surveyor Muhammad Abdul Azim.
Silver Medal for long service and good conduct.—	Sergeant F. J. Weaver, (India Miscellaneous list), Draftsman, No. 6 Drawing Office (Army Section).
Services brought to notice of the Government of India.—	Lieut.-Colonel H. H. Turner, R.E., Superintendent, Map Publication, Calcutta.
	Mr. T. A. Ferrier, C.B.E., Officer in charge, Mathematical Instrument Office, Calcutta.
	Mr. S. Woodhouse, Works Manager, Mathematical Instrument Office, Calcutta.
	Mr. S. Colquhoun, Assistant Manager, Litho., Photo.-Litho. Office, Calcutta.

12. The following table shows the distribution of officers during the year. The names of officers on deputation to Local Governments or military duty or absent on military duty followed by leave throughout the year are omitted; the names of officers, other than officers in charge, on leave, military duty, or foreign service, during the greater part of the year are also omitted

TABLE I—DISPOSITION OF OFFICERS, 1918-19.

SURVEYOR GENERAL OF INDIA—Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S., to 5th December 1918 and from 5th January to 15th March 1919. Colonel Sir Gerald P. Lenox-Conyngham, Kt., R.E., F.R.S., Officiating, from 6th December 1918 to 4th January 1919. Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., from 16th March 1919 (Officiating to 15th September 1919).

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Lieut.-Colonel A. Mears, I.A. Captain W. E. Perry, M.C., R.E.			
No. 6 Drawing Office, Simla.	Major C. J. Arbery	Mr. R. E. Saulolls ,, A. J. A. Drake, D.C.M.		26 Draftsmen, &c.
Mesopotamian Survey Party.	Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E. Bt.-Colonel F. W. Pierre, C.M.G., C.I.E., I.A. Bt.-Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Major E. T. Rich, C.I.E., R.E. ,, L. C. Thuillier, I.A. ,, L. G. Crosthwait, I.A. Mr. J. deGraaff Hunter, M.A. Major A. H. Gwyn, I.A. Bt.-Major C. G. Lewis, R.E.	Mr. S. S. McA'F. Fielding ,, C. West ,, R. C. Newland ,, E. C. O'Sullivan, D.C.M. ,, D. K. Rennick ,, D. H. Laxa ,, J. McCracken, M.B.E. ,, F. B. Kitchen ,, A. J. Booth ,, J. C. St. C. Pollett ,, Narendra Nath Chuckerbutty, L.C.E. ,, A. F. Murphy	Mr. Hayat Muhammad, K.S. ,, Nanak Chand Puri, B.A., R.S. ,, Hamid Gul, K.S. ,, Satish Chandra Mukerjee ,, Annada Prasad Ghosh ,, Lalfan Khan, I.O.S.M. ,, Abdul Latif Khan	68 Surveyors, &c.
East Africa Survey Detachment.		Mr. A. J. A. Drake, D.C.M.	Mr. Ram Prasad, R.S.	5 Surveyors.

SUPERINTENDENT, MAP PUBLICATION—Lieut.-Colonel H. H. Turner, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Major O. H. B. Trenchard, R.E.	Mr. P. Williams ,, Jagdamba Prasad ,, Abinash Chander Bose ,, Asmat-ullah Khan, R.S. ,, Priya Nath Sur ,, L. B. Fitz-Gibbon ,, A. A. Graham ,, T. F. Kitchen ,, H. T. Hughes ,, H. H. P. Butterfield ,, Jiya Lal Sahgal		
Photo.-Litho. Office, Calcutta.	Major F. J. M. King, R.E. ,, A. H. Gwyn, I.A.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier, C.B.E.			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).		Mr. P. Simpson		

SUPERINTENDENT, NORTHERN CIRCLE—Lieut.-Colonel E. A. Tandy, R.E., up to 29th November 1918. Lieut.-Colonel R. T. Crichton, C.I.E., I.A., from 30th November 1918.

	Imperial Officer	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.		Mr. J. A. Freeman ,, E. B. West ,, D. K. Rennick ,, L. Williams ,, A. A. Graham	Mr. Imam Din	20 Surveyors, &c.
No. 1 Party, *Punjab and Central India.*	Bt.-Lieut.-Colonel A. A. MacHarg, D.S.O., R.E. Captain W. E. Perry, M.C., R.E.	Mr. H. H. B. Hanby ,, G. J. S. Rae ,, A. M. Talati, L.C.E. ,, R. C. Hanson ,, G. A. Norman	Mr. Paras Ram ,, Jamna Prasad, R.S. ,, Jagdeesh Prasad Vastav ,, Muhammad Khan	34 Surveyors, &c.
No. 2 Party, *United Provinces and Delhi Province.*	Major R. Foster, I.A.	Mr. H. P. D. Morton ,, J. A. Calvert ,, Duni Chand Puri	Mr. Lakshmi Dutt Joshi ,, Ghulam Hasan ,, Daulat Ram Vohra.	23 Surveyors, &c.
No. 3 Party, *United Provinces and Punjab.*		Mr. H. H. B. Hanby ,, B. M. Berrill ,, J. H. Johnson ,, Moqimuddin	Mr. Paras Ram ,, Amir Abdul Salam Matlub Ahmad	31 Surveyors, &c.
No. 4 Party, *United Provinces.*	Lieut.-Colonel E. A. Tandy, R.E.			2 Clerks.
Sind-Sagar Party, *Punjab.*		Mr. Dhani Ram Verma ,, J. C. C. Lears ,, A. M. Talati, L.C.E. ,, Abdul Karim, B.A. ,, Moqimuddin	Mr. Chuni Lal Kapur ,, Nabidad Khan	27 Surveyors, &c. 138 Local Revenue staff.
Riverain Survey Party, *Punjab.*		Mr. Maya Das Puri, R.S.	Mr. Paras Ram ,, Ram Narayan Hastir ,, Lakshmi Dutt Joshi ,, Vidya Dhar Chopra	73 Surveyors, &c.
Simla Survey Detachment, *Simla.*		Mr. W. H. Strong, M.B.E.		11 Surveyors, &c.
Eastern Persia Survey Party.	Lieut.-Colonel H. L. Crosthwait, R.E.	Mr. P. A. T. Kenny ,, E. B. West ,, L. Williams ,, G. E. R. Cooper ,, F. J. Grice	Mr. Muhammad Husain Khan ,, Muhammad Husain ,, Shib Lal ,, Afraz Gul Khan	28 Surveyors, &c.
North-West Frontier Survey Party.	Major H. McC. Cowie, R.E. Bt.-Major C. G. Lewis, R.E.	Mr. R. C. Hanson ,, B. T. Wyatt ,, J. A. Calvert		9 Surveyors, &c.
Quetta Survey Detachment.		Mr. F. J. Grice	Mr. Shib Lal	3 Surveyors.
Birjand Survey Detachment.		Mr. L. Williams ,, G. A. Norman	Mr. Afraz Gul Khan	3 Surveyors.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1918-19.

SUPERINTENDENT, SOUTHERN CIRCLE { Colonel T. F. B Renny-Tailyour, C.S.I., R.E., up to 5th March 1919. Major L. C. Thuillier, I.A., from 6th to 28th March 1919. Lieut.-Colonel W. M. Coldstream, R.E., from 29th March 1919.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.		Mr. J. H. Nichol „ F. P. Walsh	Mr. B. V. Narayana Rao	37 Draftsmen, &c.
No. 5 Party, *Central Provinces.*	Major L. C. Thuillier, I.A.	Mr. V. W. Morton „ Haji Abdul Rahim, K.B. „ F. C. Pilcher	Mr. P. S. Venguswami „ Damodar Khadilkar „ Masud Khan	33 Surveyors, &c.
No. 6 Party, *Bombay and Hyderābād.*		Mr. J. O'B. Donaghey „ E. A. Meyer „ Munshi Lal, B.A. „ N. S. Hariharа Iyer	Mr. Ekanth Battu „ K. Mandanna „ E. N. Natesan, B.A.	23 Surveyors, &c.
No. 7 Party, *Madras.*		Mr. W. M. Gorman „ C. E. C. French „ H. B. Simons „ F. W. Smith „ M. S. Ganesa Aiyar	Mr. Pulin Behari Roy	18 Surveyors, &c.
No. 8 Party, *Madras.*		Mr. W. M. Gorman „ C. E. C. French „ M. Mahadeva Mudaliar, M.A.	Mr. K. Narayanaswami Chetti „ H. Narasimhamurti Rao „ Shaikh Muhammad Salik	37 Surveyors, &c.
No. 20 Party, *Cantonments and Military Stations in the 5th, 6th and 9th Divisions.*		Mr. B. R. Hughes „ C. E. C. French „ O. D. Jackson	Mr. Dharmu „ Jitendra Mohan Mukerji	22 Surveyors, &c.
Training Section, *Mysore.*		Mr. S. F. Norman	Mr. Hari Ram Chandra Jogalekar.	11 Surveyors, &c. and Pupils.
Salonika Survey Detachment.		T. Capt. H. B. Simons Mr. E. T. Wyatt	Mr. Jamna Prasad, R.S.	14 Surveyors, &c.
South-West Persia Survey Detachment.		Mr. F. H. Grant		5 Surveyors.

SUPERINTENDENT, EASTERN CIRCLE —Lieut.-Colonel C. L. Robertson, C.M.G., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.		Mr. J. H. S. Wilson „ Pramadaranjan Ray, R.S. „ E. Claudius		24 Surveyors, &c.
No. 9 Party, *Bengal.*		Mr. E. J. Biggie „ A. B. Hunter „ Amar Krishna Mitra „ H. T. Hughes	Mr. Amulya Charan Ghosh „ Gopal Lal Mitra	23 Surveyors, &c.
No. 10 Party, *Upper Burma.*		Mr. M. C. Petters „ W. G. Jarbo „ H. H. Creed „ Dhirendra Nath Banerjee, L.C.E.	Mr. Dhirendra Nath Saha „ Ram Prasad, R.S. „ Bhamba Ram	27 Surveyors, &c.
No. 11 Party, *Lower Burma.*		Mr. J. O. Graff „ O. J. H. Hart „ E. M. Kenny „ C. O. Picard „ A. V. Dickson	Mr. Pratul Chandra Sen Gupta, B. Sc.	26 Surveyors, &c.
No. 12 Party, *Assam.*	Captain F. B. Scott, I.A.	Mr. H. W. Biggie „ E. G. Hardinge-Pramadaranjan Ray, R.S. „ Prafulla Chandra Mitra, B.A. „ K. S. Gopalachari, B.A.	Mr. Girija Sonker Bagchi	25 Surveyors, &c.
Special Burma Forest Survey Party, *Upper Burma.*		Mr. H. W. Biggie „ W. G. Jarbo	Mr. Bhamba Ram	9 Surveyors, &c.
Kūki Survey Detachment, *Assam.*		Mr. H. T. Hughes		3 Surveyors.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1918-19.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY—Colonel Sir Gerald P. Lenox-Conyngham, Kt., R.E., F.R.S.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	*(Attached)* Mr. H. G. Salmond (on deputation from Eastern Bengal Railway).	Mr. H. A. Charrier „ C. S. McInnes		
Computing Office	Major H. McC. Cowie, R.E. „ C. M. Thompson, I.A.	Mr. Hanuman Prasad	Mr. Sarat Kumar Mukerji „ Karuna Kumar Das, B.A.	42 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Colonel R. A. Wauhope, C.B., C.M.G., C.I.E., R.E. Major F. J. M. King, R.E.	Mr. C. C. Byrne „ Rama Prasad Ray, B.A. „ O. N. Pushong „ J. McCraken, M.B.E. „ T. F. Kitchen „ Raj Bahadur Mathur, B.A.	Mr. Ram Singh, R.S. „ Jugal Behari Lal	165 Draftsmen, &c.
No. 13 Party, *(Astronomical)*.	Major H. McC. Cowie, R.E. „ M. O'C. Tandy, D.S.O., O.B.E., R.E. Bt.-Major C. G. Lewis, R.E. Major C. M. Thompson, I.A.			2 Computers, &c.
No. 14 Party, *(Pendulum)*.	Major H. McC. Cowie, R.E. „ C. M. Thompson, I.A.			1 Clerk.
No. 15 Party, *(Triangulation)*.	Major R. H. Thomas, D.S.O., R.E. „ R. Foster, I.A. Bt.-Major C. G. Lewis, R.E.	Mr. H. G. Shaw „ C. S. McInnes „ Abdul Karim, B.A.		9 Computers, &c.
No. 16 Party, *(Tidal)*.		Mr. O. C. Ollenbach „ Syed Zille Hasnain, K.S.		20 Computers, &c.
No. 17 Party, *(Levelling)*.		Mr. H. G. Shaw „ O. N. Pushong „ D. H. Luxa „ J. McCraken, M.B.E. „ T. F. Kitchen „ K. S. Gopalachari, B.A. „ Narendra Nath Chuckerbutty, L.C.E.	Mr. Karuna Kumar Das, B.A. „ Satish Chandra Mukerjee	12 Computers, &c.
No. 18 Party, *(Magnetic)*.		Mr. E. C. J. Bond, V.D. „ Nikunjo Ronjon Mazumdar	Mr. Bidhu Bhusan Shome	2 Magnetic Observers. 12 Computers, &c.
No. 19 Party, *(Base Line)*.	Colonel Sir Gerald P. Lenox-Conyngham, Kt., R.E., F.R.S. Major H. McC. Cowie, R.E. Bt.-Lt.-Colonel A. A. McHarg, D.S.O., R.E. Major C. M. Thompson, I.A.			1 Clerk.

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PART 2.—WORK OF FIELD PARTIES, &c.

1.—TOPOGRAPHICAL SURVEYS.

13. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905 and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shown in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 588,000 square miles are likely to be surveyed on the half-inch or smaller scale.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,580	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
1917-18 ...	ditto ...	4,202	12,181	8,396	24,779
1918-19 ...	ditto ...	**509***	**7,263**	**6,176†**	**13,948**
Total areas completed to date ..		**212,310**	**162,430**	**135,570**	**510,310**
Approximate areas for the whole topographical programme.		**750,000**	**542,800**	**528,800**	**1,821,600**
Approximate areas remaining for survey.		**537,690**	**380,370**	**393,230**	**1,311,290**

* Excluding 82 square miles of biennial Delhi revision survey on scale of 4 inches = 1 mile.

† Excluding 3,738 square miles of revision survey (provisional) on scale of ¼ inch = 1 mile.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1918-19.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
NORTHERN CIRCLE.						
No. 1 Party—*United Provinces, Punjab, Central India.*						
Open undulating mostly cultivated country with few hills.	1-inch Original Survey Military	92	320	75,152	Indeterminate (a)	(a) The areas surveyed are so small and so far apart, entailing such costly moves, that it is impossible to arrive at a rational cost-rate for the actual work of survey.
Open undulating mostly cultivated country with few hills.	3-inch Original Survey Military	133				
Flat valley intersected by usually dry water courses between high ranges of hills.	3-inch Original Survey Military	95				
	Large-Scale Surveys					
No. 2 Party—*United Provinces, Delhi Province and Rājputāna.*						
Low rocky hills and cultivated plains.	4-inch Revision Survey ...	82	82	74,556 (b)	Indeterminate (a)	(b) Includes Rs. 5,333 debitable to Rājputāna and Rs. 266 debitable to Forest Department, U.P.
	Large-Scale Surveys					
No. 3 Party—*United Provinces.*						
Wooded hills	4-inch Original Special Forest Survey.	189	189	92,051 (c)	Indeterminate (a)	(c) Includes Rs. 18,429 debitable to Forest Department, U. P.
TOTALS, NORTHERN CIRCLE:—		591 sq. m.		Rs. 2,41,759	Cost-rate Indeterminate.	
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**SOUTHERN CIRCLE.**
No. 5 Party—*Central Provinces.*						
Well-wooded hills and cultivated plains.	1-inch Original Survey ...	979	1,442	55,112 (d)	38·2	(d) Excludes Rs. 13,104, cost of ½-inch mapping, and Rs. 2,550, cost of 3-inch mapping.
Wooded intricate hills	... 1-inch Revision Survey ...	463				
No. 6 Party—*Bombay and Hyderābād.*						
Undulating and cultivated	... ½-inch Original Survey ...	178	2,359	78,282	33·2	
Ditto ditto	... 1-inch Original Survey ...	274				
Ditto ditto	... 1-inch Supplementary Survey ...	1,670				
Wooded hills	... 1½-inch Original Survey ...	237				
No. 7 Party—*Madras.*						
Varied, mostly open plains	... 1-inch Original Survey ...	2,226	2,238	56,234	25·1	
Open, scrub jungle	... 2-inch Original Survey ...	12				
No. 8 Party—*Madras.*						
Wooded intricate hills, undulating and cultivated.	... 1-inch Supplementary Survey ...	1,182	1,224	63,823 (e)	52·1	(e) Excludes Rs. 4,935, cost of ½-inch mapping.
Wooded hills	... 1-inch Revision Survey ...	42				
TOTALS, SOUTHERN CIRCLE:—		7,263 sq. m.		Rs. 2,53,401	Cost-rate 34·8	

Table III.—(Concluded).—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1918-19.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
						EASTERN CIRCLE.
No. 9 Party—*Bengal.*						
Flat and cultivated plains	... 1-inch Original Survey ...	548	548	29,858 (*f*)	54·5	(*f*) Excludes Rs. 9,752, cost of ½-inch mapping, and Rs. 21,409, cost of 12-inch survey.
No. 10 Party—*Upper Burma.*						
High hills, densely wooded	... ¼-inch Revision Survey (Provisional).	367 (*i*)	3,516	1,45,658 (*g*)	41·4	(*g*) Includes Rs. 31,696, debitable to the Forest Department on account of special forest surveys, and Rs. 3,426 on account of ½-inch survey which, as only provisional, will be redone on the ½-inch scale in the near future.
High mountains with densely wooded valleys.	½-inch Original Survey ...	2,346				
Densely wooded hills	... 1-inch Original Survey ...	748				
Wooded hills, free of undergrowth	2-inch Original Special Forest Survey.	55				
No. 11 Party—*Lower Burma.*						
High hills, densely wooded, from 400 to 9,000 feet.	½-inch Revision Survey (Provisional).	1,080 (*i*)	2,323	1,52,587 (*h*)	65·7	(*h*) Includes cost of Maymyo Drawing Office and Rs. 4,234 on account of ½-inch survey which, as only provisional, will be redone on the ½-inch scale in the near future.
High hills and low undulating ground containing large areas of swamp and marsh, densely wooded.	1-inch Original Survey ...	1,217				
Densely wooded hills	... 1-inch Revision Survey ...	26				
No. 12 Party—*Assam.*						
Plains, mostly densely wooded and partly under cultivation and a portion of a range of hills.	1-inch Original Survey ...	1,163	1,216	96,907	79·7	
Plains, mostly densely wooded and partly under cultivation and a portion of a range of hills.	1-inch Revision Survey ...	30				
Densely wooded plains	... 2-inch Original Survey ...	23				
Special Burma Forest Survey Party—*Upper Burma.*						
Wooded hills	... 2-inch Original Survey ...	20	20	19,871	993·5	
Kūki Survey Detachment—*Assam.*						
Hilly and for the most part forest clad.	½-inch Revision Survey (Provisional).	2,291 (*i*)	2,291	10,057 (*j*)	4·4	(*i*) Has not been included in Table II as being only provisional. (*j*) Refers to plane-tabling only.
TOTALS, EASTERN CIRCLE:—			**9,914 sq. m.**	**Rs. 4,54,938**	Cost-rate 45·9	
GRAND TOTALS:—			**17,768 sq. m.**	**Rs. 9,50,098**	Cost-rate Indeterminate.	

NORTHERN CIRCLE (*vide* Index map No. 1).

14. No. 1 Party.—Three Artillery Practice Camps, comprising an area of 228 square miles, were surveyed on the scale of 3 inches = 1 mile in the vicinities of Jhānsi, Mhow and Quetta. In the case of the first named 16 square miles, and in the case of the second named 76 square miles, were surveyed in addition on the scale of 1 inch = 1 mile, for subsequent enlargement to complete the sheets of the Artillery Practice Camp maps to margin (*vide* also page 45).

The party also carried out large-scale surveys of the cities of Lahore and Ferozepore for the preparation of "Town Guide" maps (*vide* page 18).

15. No. 2 Party.—Carried out the biennial revision survey of 64 square miles of Imperial Delhi and New Cantonment, and of 18 square miles outside Imperial limits, on the scale of 4 inches = 1 mile (*vide* page 18).

The activities of this party were mainly confined to large-scale surveys of the cities of Allahābād, Cawnpore, Benares and Agra for the preparation of "Town Guide" maps (*vide* page 18), and to a large-scale survey of the hill station of Mount Abu and vicinity, still in progress (*vide* page 18).

16. No. 3 Party.—This party only undertook the survey of 189 square miles in the Dehra Dūn district of the United Provinces, and Dhādi and Raingarh States, Punjab. The survey was executed on the scale of 4 inches = 1 mile in connection with reserved forests (*vide* page 17).

17. No. 4 Party.—This party continued in abeyance throughout the year, the Officer in charge being specially employed in connection with the triangulation and traverse records of the Northern Circle, and on other miscellaneous duties.

18. Training.—25 pupil surveyors were entertained in June 1919 and drafted into the parties, &c., for preliminary training in drawing during the recess season as follows:—

To No. 2 Party	...	6 men
,, ,, 3 ,,	...	6 ,,
,, Sind-Sāgar Party	...	6 ,,
,, No. 3 Drawing Office	...	7 ,,

At the close of the recess these men will take the field with No. 2 Party for training in survey.

In addition to the men referred to above, 7 soldier surveyors and 14 pupil surveyors are undergoing their first and second year's training respectively in No. 2 Party making a total of 46 men under training.

19. Recess Work.—As in previous year, the programme of fair-mapping has been considerably retarded owing to special work on "Town Guide" maps and transfer of a large number of good surveyors and draftsmen to parties and detachments on active service on the North-West Frontier, in Persia, Mesopotamia and elsewhere.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1919:—

Sheets on the 1-inch scale	...	17.
Sheets on the 2-inch scale	...	12.
Royal Artillery Practice Camp Map	...	1.
Town Guide Maps ...	...	7.
Simla Extension Survey ...	...	5.

20. Particulars of special work done by Nos. 1, 2, 3, the Sind-Sāgar, and Riverain Parties, are given on pages 18, 19, 45 and 46.

SOUTHERN CIRCLE (*vide* Index map No. 1).

21. No. 5 Party.—This party surveyed an area of 1,442 square miles on the scale of 1 inch = 1 mile in the Jubbulpore, Mandlā and Seoni districts of the Central Provinces, and triangulated an area of 1,652 square miles in the Chhindwāra, Seoni and Bālāghāt districts of the Central Provinces. The country consisted of jungle-clad hills and of well-wooded cultivated plains. The majority, including the head-quarters of the party, remained at Bangalore throughout the year and was principally employed on the fair-mapping of half-inch sheets compiled from published sheets of the one-inch map.

22. No. 6 Party.—This party surveyed an area of 2,359 square miles on different scales in the Bijāpur district of Bombay and the Gulbarga, Raichūr and Mahbūbnagar districts of Hyderābād (Deccan), and triangulated an area of 1,699 square miles in the Nalgonda and Warangal districts of Hyderābād. The country surveyed is undulating and highly cultivated, except the forest areas which consist of sparsely wooded hills.

23. No. 7 Party.—This party surveyed an area of 2,238 square miles on different scales in the Guntūr, Kurnool and Nellore districts of Madras. The country surveyed comprised open expanses of cultivated land, with isolated barren rocky hills standing out conspicuously from the plains and well distributed over the area.

24. No. 8 Party.—This party surveyed an area of 1,224 square miles on the scale of 1 inch = 1 mile in the Tinnevelly district and the Travancore State of Madras, and traversed 248 linear miles in the Rāmnād and Tanjore districts of Madras. The country surveyed comprises a portion of the Western Ghāts, mostly forest clad, bold and rugged in its northern reaches, but losing much of its characteristic boldness and steepness as it approaches the sea in its southward trend to Cape Comorin. It divides the country on its flanks into undulating and low lying plains, intensely cultivated, and dotted with numerous scattered huts and village sites and covered with a dense growth of palmyras.

25. Training Section.—This section took the field in the Kolār district of Mysore, 9 pupil surveyors received instruction in topographical surveying.

26. Recess Work.—The whole of the area surveyed this year will be fair-mapped before the close of this recess season, leaving the parties with no arrears of fair-mapping for next recess season. All the sheets surveyed in the previous year have been fair-mapped, with the exception of one sheet which requires a further reference to the ground but is otherwise completed.

Half-inch mapping from published modern one-inch sheets and quarter-inch mapping are dealt with on page 42.

27. The report on the survey of cantonments and military stations, undertaken by No. 20 Party, is entered on page 20.

EASTERN CIRCLE (*vide* Index map No. 1).

28. No. 9 Party.—This party executed a topographical survey, on the scale of 1 inch = 1 mile, of 548 square miles in the districts of

Burdwān, Hooghly, Nadiā and Twenty-four Parganas of Bengal, and in the French Settlement of Chandernagore.

The country surveyed lies in the plains of Bengal. It is covered by a number of large and well wooded villages, the intervening spaces being under cultivation.

The river Hooghly flows due south through the eastern portion of the work, and, on its banks are situated several large towns and villages of great commercial importance as centres of jute and paper manufacture and of other industries.

The party also carried out surveys, on the scale of 12 inches = 1 mile, of the towns of Barrackpore and Dum-Dum for the preparation of "Town Guide" maps (see page 19).

29. No. 10 Party.—This party surveyed an area of 3,149 square miles, on the scales of 2 inches, 1 inch and ½ inch = 1 mile, in Meiktila, Myitkyinā, and Putao districts and unadministered territory of Upper Burma. It also traversed an area of 254 square miles in the Meiktila and Kathā districts in advance, for special forest surveys on the scales of 4 inches and 2 inches = 1 mile, and triangulated 1,700 square miles in advance for topographical surveys on the scale of one inch = 1 mile, in the Kathā district. The country surveyed in the Meiktila and Kathā districts consisted of well wooded hills at an average elevation of 3,000 feet. In the Myitkyinā and Upper Chindwin districts, the area surveyed consisted of high ridges separated by broad valleys covered with dense forest growth. In the Putao district, the area comprised the high mountainous and hitherto practically unknown region at the source of the Irrawaddy river, and ranged in altitude from 2,000 feet to 19,000 feet above mean sea level. The highest snow peak fixed in this area, which is probably the highest point in the province of Burma, lies at the source of the Nam Tamai, one of the two tributaries of the Irrawaddy in its upper reaches, and has an elevation of 19,315 feet.

A Forest Survey Detachment was constituted on 1st December 1918. The personnel of this detachment was transferred to the Special Burma Forest Survey Party on its formation on 1st May 1919 (*vide* page 17).

A surveyor was deputed during the field season to accompany the Kūki Punitive Measures Force operating in the Somra tract on the Burma-Assam frontier, and surveyed, on the scale of ¼ inch = 1 mile, an area of 367 square miles.

A section of the party consisting of 6 surveyors under a Provincial officer remained in the Putao district during the summer to complete the detail survey of the region, usually under snow in the winter, at the headwaters of the Irrawaddy.

30. No. 11 Party.—The party continued operations in Lower Burma, and surveyed, on the scale of 1 inch = 1 mile, in the Tavoy and Mergui districts, 1,243 square miles, and triangulated an area of 1,810 square miles in advance for detail survey. Of the total area surveyed 26 square miles is revision survey on the scale of 1 inch = 1 mile.

A surveyor was deputed to the Kūki Punitive Measures Force operating in the Somra tract on the Burma-Assam frontier, and surveyed, on the scale of ¼ inch = 1 mile, an area of 1,080 square miles.

The country surveyed in the Mergui district comprised the basin of the Little Tenasserim river and its two principal tributaries. Except for a small area lying at the confluence of these tributaries with the main

river, the country is thickly wooded, waterlogged in parts, and rises gradually to the main watershed which separates this district from Siam. The area surveyed is of much historical interest being the *locale* of the once famous overland route, which centuries ago played so important a part in the history and commerce of the ancient kingdom of Siam.

31. No. 12 Party.—This party surveyed 1,193 square miles, on the scale of 1 inch = 1 mile, and 23 square miles of reserved forests, on the scale of 2 inches = 1 mile, in the districts of Lakhimpur and Sibsāgar and the Sadiyā frontier tract of Assam. 2,735 square miles of triangulation and 258 linear miles of traversing, covering an area of 410 square miles, was carried out in districts Lakhimpur, Khāsi and Jaintiā Hills, Sylhet and Nowgong, to provide points for detail survey in 1919-20. The area surveyed was flat country partly covered with dense jungle of trees, cane, and tall grass and partly cultivated; and the area triangulated and traversed comprised hills rising to 5,000 feet and plains, both covered with dense jungle, except portions of the plains area which have been cleared for cultivation.

32. Kūki Survey Detachment.—This detachment was formed at the end of March 1919 to revise the existing maps of the areas of the Manipur State, in which the Kūki Punitive Measures Force was then operating, in so far as the political and military circumstances would permit. It consisted of 3 plane-tablers under an officer of the Provincial Service and completed the revision, on the $\frac{1}{4}$-inch scale, of 2,291 square miles of the existing map, in the southern part of the state and along part of the northern boundaries of the Chin Hills and Lushai Hills, by the middle of June. The work was based on existing triangulation and the whole area dealt with will come under systematic survey in the course of the next few years. It has therefore been considered as merely provisional.

33. Recess Work.—Only 2 one-inch sheets, out of 21 one-inch and 2 half-inch sheets surveyed during the year under report, were received in the circle drawing office for publication up to 30th September 1919.

The fair-mapping of 1 one-inch sheet surveyed in 1917-18 was in arrears on 30th September 1919.

II.—FOREST SURVEYS.

34. Details of the topographical surveys of reserved forests executed by field parties of the Survey of India for the year under report are given below. In the majority of cases the surveys were carried out on the scale of 2 inches = 1 mile, but in special cases the 4 inches and 1 inch = 1 mile scales were used. Boundary surveys on the 4 inches = 1 mile scale were made where required.

NORTHERN CIRCLE.

35. United Provinces. Western Forest Circle.—In the *Chakrātā Forest Division*, 154 square miles of Reserved Forests and 35 square miles of overlap were surveyed on the scale of 4 inches = 1 mile.

SOUTHERN CIRCLE.

36. Madras. Central Forest Circle.—In the *Nellore district*, 11·7 square miles comprising the Pedairlapadu, Pedacherlopalle, Magalicherla and Ayyavaripalle Reserved Forests, were surveyed on the scale of 2 inches = 1 mile.

EASTERN CIRCLE.

37. Assam. Eastern Forest Circle.—In the *Lakhimpur Forest Division*, 22·6 square miles of the Kadam and Pānigaon Reserved Forests were surveyed on the scale of 2 inches = 1 mile, and 1·7 miles of boundaries were traversed in advance of further detail surveys.

Western Forest Circle.—In the *Khāsi and Jaintiā Hills Forest Division*, 10·6 miles were traversed in advance for the survey of Blocks I and II of the Narpuh Reserved Forest.

38. Burma. Northern Forest Circle.—Preliminary to future detail surveys, boundary traverses were executed in the *Katha Forest Division*, 28·4 miles in the Mezabya Reserved Forest, and in the *Mansi Forest Division*, 100·7 miles in the Mode, Hwelit, Nansaung and Chaunggyibya Reserved Forests. In addition, 37·3 miles of interior lines were traversed.

Southern Forest Circle.—In the *Meiktila Forest Division*, 74·4 square miles of Reserved Forests were surveyed on the scale of 2 inches = 1 mile, and, for further surveys, 137·9 miles of forest boundaries and 23·6 miles of interior lines were traversed.

Tenasserim Forest Circle.—In the *Tenasserim Forest Division* 27·6 miles of boundaries were traversed in the Heinze and Kaleinaung Reserved Forests.

Special Burma Forest Survey Party.—This party was formed on the 1st May 1919, from a nucleus which had been constituted as a section of No. 10 Party, and worked in the Northern and Southern Forest Circles; the area surveyed is incorporated above.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

39. No. 1 Party.—An area of 2·2 square miles was surveyed on the scale of 16 inches = 1 mile for "Town Guide" maps, comprising 1·7 square miles in Lahore city and environs and 0·5 square miles in Ferozepore city, both places being congested city areas.

40. No. 2 Party.—This party was employed on the revision surveys of the cities of Allahābād, Cawnpore and Benares on the scale of 16 inches = 1 mile, Agra city on the scale of 13·2 inches = 1 mile, and the cantonments, civil lines and environs of Allahābād, Agra, Lucknow, Cawnpore and Benares on the scale of 6 inches = 1 mile. Total area surveyed was 120·9 square miles.

The city of Lucknow will be mapped on the scale of 16 inches = 1 mile from air photographs taken for the purpose.

The survey of Mount Abu was started during the year in order to comply with a request from the Secretary, Public Works Department, Rājputāna, for the survey of the station itself, and its extension as acquired on lease by the Government from the Sirohi Darbār.

The area concerned comprises some 5,500 acres, averaging 4,000 feet above sea level, the leased portion consists of some cultivated and grass lands, but is mostly rocky ground covered with scrub jungle and trees, and inhabited area with intricate details.

The scale of survey is 24 inches = 1 mile, with a vertical interval of 10 feet for area suitable for building sites, and 50 feet for the rest. The area under survey is 5,000 acres with a few small over-laps making a total of some 5,500 acres. The necessary triangulation and traverse on which the survey is being based is completed and the detail work is now in hand, 584 acres has so far been completed.

In addition a small section of the party carried out the second of the biennial revisions of the four-inch maps of Imperial Delhi and Delhi New Cantonment during the year under report. The area dealt with amounted to 82 square miles, 64 of which comprised Imperial Delhi and the New Cantonment, and 18 square miles being portions outside the Imperial limits. This revision disclosed fairly considerable changes since the execution of the last survey on the same scale. These changes were due partly to demolitions, new lays-out and new construction, and partly to levelling operations, the latter necessitating a good deal of recontouring of the area of the Imperial city.

The cost-rate of revision survey works out at Rs. 36-4-0 per square mile, and that of mapping at Rs. 70-4-0 per square mile.

41. No. 3 Party.—*(Simla Survey Detachment).*—The detachment remained at Simla, and carried out the survey of certain areas of the Simla Extension Scheme.

During the year the following work was undertaken :—

Surveys near Potter's Hill, Jutogh Ridge, Prospect Hill and Mushobra.

Out of 19 sheets, 11 have been sent for publication, the mapping of 5 is well advanced and these will be ready in October.

42. The Punjab Riverain Survey Party.—The party continued the work of traversing and laying down base lines. 556 linear, and 611 square miles of main circuits; and 3,115 linear, and 611 square miles of minor traverses were executed; 944 theodolite stations of the former, and 13,003 of the latter, in 179 villages, were fixed.

1,026 corners of 342 squares were demarcated in 982 square miles with permanent mark-stones on both banks of the rivers Indus, Sutlej, Chenāb and Rāvi in districts Dera Ghāzi Khān, Muzaffargarh, Multān and the Bahāwalpur State, to serve as bases for the future survey and demarcation of boundaries and fields in the beds of the rivers.

2,034 plotted, and 646 boundary *masāvis* (settlement mapping sheets) on the scale of 1/2,640, and 41 four-inch sheets were traced, and supplied to the settlement officers concerned. Three 4-inch sheets of the Chenāb in districts Multān and Muzaffargarh were recompiled and completed. Besides these, 436 boundary *masāvis* were partly compiled on the scale 220 feet to an inch for the next season's work; and 190 miscellaneous traces were prepared, and all the traverse stations marked during the year were plotted on 38 four-inch sheets. Some of the computation volumes still remain to be completed.

At the request of the Settlement Officer, rectangulation in the Multān district was undertaken during March, and was finished in April 1919 in five riverain villages of the Sutlej in the Mailsi *Tahsīl*. The work was based on the Sutlej riverain traverse. 153 corners of 51 rectangles were demarcated with pegs in 22 square miles, forming 46 blocks. 176 stations were fixed with theodolite, and 34 linear miles traversed.

At the request of the Deputy Commissioner, traversing of Jhelum town was commenced in March 1919 and was finished in April 1919. The work was based on the riverain traverse. 209 stations were fixed with theodolite and were permanently marked with stones; and 23 linear miles were traversed in 1,280 acres. Two plotted sheets, on the scale 16 inches = 1 mile, were supplied during May to the Deputy Commissioner, Jhelum.

43. No. 9 Party.—During the year under report, the party carried out a survey of towns of Barrackpore and Dum-Dum, on the scale of 12 inches = 1 mile, for the preparation of up to date "Town Guide" maps.

Field operations in connection with this survey commenced in the beginning of October 1918 and were completed by the end of March 1919.

The survey was partly supplementary and partly original. The former was based on existing traverse data and the latter on a theodolite traverse carried out early in the season in advance of the detail survey.

This latter traversing was connected with 3 stations of the Calcutta Longitudinal Series and the computations were completed in the field. 75·4 linear miles were traversed over an area of 16 square miles.

The supplementary survey comprised the cantonments of Barrackpore, Ishapore and Dum-Dum and extended over an area of 2,481 acres.

The area of original survey in the vicinity of Barrackpore extended westward to include the river Hooghly and a strip, about 200 feet wide, on its right bank. The total area of original survey in both Barrackpore and Dum-Dum is 10,162 acres.

The map of the Barrackpore area has been drawn in 4 sheets, each measuring 34·5 inches by 28·5 inches; that of the Dum-Dum area is in one sheet, measuring 27 inches by 27 inches; all for publication on the scale of survey.

44. No. 20 Party.—During the year under report, the party completed the survey of the cantonments and military stations of Bellary, Secunderābād and part of Bolārum on the scale of 16 inches = 1 mile and 5 *bāzārs* of Secunderābād on the scale of 64 inches = 1 mile. A revision survey of the *bāzārs* of Secunderābād and Bolārum, on the scale of 50 feet = 1 inch, is in progress.

The traversing and triangulation of Secunderābād and Bolārum, St. Thomas's Mount, Pallāvaram, the zone of Fort St. George, Wellington and of 5 small military areas at Ootacamund and Wellington have been completed, and that of West Hill and the Madras military lands is in hand.

The fair-mapping of the following cantonments and military stations has been completed during the year:—Jatta, Zām, Jandola, Drazinda, Nasirābād, Ghairat, Chaman, Drosh, Chitrāl, Thath, New Delhi, Agar and Erinpura, and that of Jhānsi, Aurangābād, Ahmadnagar, Manora, Hosūr and Bellary is well in hand.

Forty sheets have been fair-mapped and submitted for publication and forty-nine, twenty-two of which are of cantonments the surveys of which have been completed, are at different stages of completion.

The total out-turn of detail survey on the scale of 16 inches = 1 mile was 20,865 acres and, on the scale of 64 inches = 1 mile 92 acres, and the plans of 494 acres, on the scale of 50 feet = 1 inch were corrected. The total areas fair-mapped were 21,212 acres on the scale of 16 inches = 1 mile and 233 acres on the scale of 64 inches = 1 mile.

The total cost of detail survey on the scale of 16 inches = 1 mile was Rs. 20,781 and the cost-rate Re. 1 per acre, the corresponding figures for survey on scale of 64 inches = 1 mile being Rs. 1,698 and Rs. 18·5 per acre.

The total cost of correcting plans on the scale of 50 feet = 1 inch was Rs. 4,804 and the cost-rate Rs. 9·7 per acre.

The total cost of traversing for 16-inch survey was Rs. 18,161 and the cost-rate, Rs. 53·0 per linear mile.

The total cost of fair-mapping on the 16-inch scale was Rs. 7,115 and the cost-rate Re. 0·3 per acre, corresponding figures for the 64-inch scale being Rs. 1,104 and Rs. 4·7 per acre.

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scale of 16 inches = 1 mile, up to the end of 1918-19.

(1) Bakloh Cantonment.
(2) Bannu do.
(3) Chaman do.
(4) Dehra Dūn do.
(5) Deoli do.
(6) Fort Lockhart do.
(7) Guna do.
(8) Hangu do.
(9) Hāpur (Bābūgarh) Remount Depôt.
(10) Jhelum Cantonment.
(11) Jullundur do.
(12) Kālka do.
(13) Kamptee do.
(14) Landour do.
(15) Meerut do.
(16) Neemuch Cantonment.
(17) Peshāwar do.
(18) Quetta do.
(19) Quetta Civil Station.
(20) Rājkot Cantonment.
(21) Rāwalpindi do.
(22) Sahāranpur Remount Depôt.
(23) Sanāwar Cantonment.
(24) Saugor do.
(25) Siālkot do.
(26) Simla Indian Infantry Lines.
(27) * Sitābaldī Fort (Nāgpur).
(28) Thal Cantonment.
(29) Topa do.

* (On scale 24 inches = 1 mile).

IV.—THE TRIGONOMETRICAL SURVEY.

GEODETIC OPERATIONS.

45. No. 13 Party.—Astronomical.—No latitude operations were carried out during the year under report and the personnel of this party was employed at the Head Quarters Office of the Trigonometrical Survey.

46. No. 14 Party.—Pendulum.—No pendulum operations were carried out during the year under report and the personnel of this party was reduced to a minimum and employed in miscellaneous work.

47. No. 15 Party. Triangulation.—The party did not take the field during field season 1918-19.

48. No. 16 Party.—Tidal Operations.—During the year under report tidal registrations were carried out by means of self-registering tide-gauges at the stations given in the following list:—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		REMARKS.
1.	Aden	1879 ...	Still working	40		
2.	Karāchi ...	1868 ...	1880	*13	52	*With a small tide-gauge.
		1881 ...	Still working	39		
3.	Bombay (Apollo Bandar)	1878 ...	,,	41		
4.	Bombay (Prince's Dock)	1888 ...	,,	31		
5.	Madras ...	1880 ...	1890	10	34	
		Restarted 1895	Still working	24		
6.	Kidderpore ...	1881 ...	,,	38		
7.	Rangoon ...	1880 ...	,,	39		
8.	Moulmein ...	1880 ...	1886	6	16	
		Restarted 1909	Still working	10		
9.	Port Blair ...	1880 ...	,,	39		

In addition to the above, the actual records of high and low water at Bhaunagar, Chittagong and Akyab were obtained from tide-pole readings taken during day-light by the Port Officers concerned.

Tidal observations on an ordinary wooden tide-gauge at Basrah were taken by the military authorities, and a copy of the record was supplied to this department by the Director, Inland Water Transport, Mesopotamia. The observations for the year commencing 1st January 1918 were reduced by the method of harmonic analysis and the constants thus deduced were used in the computation of data for the Basrah tide-tables for 1920. These data were forwarded on 30th April 1919 to the Director, National Physical Laboratory, Teddington, England, for the preparation of the tide-tables with the aid of the tide predicting machine.

The tide-tables have not yet been received.

Tidal registrations at the 9 observatories now working have, on the whole, been carried out satisfactorily and will be continued during the coming year.

All the above observatories with the exception of Aden were inspected during the year under report.

49. In the following table are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken by self-registering tide-gauges :—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

YEAR.	AT OPEN COAST STATIONS.							AT RIVERAIN STATIONS.						
	Number of Stations.	IN TIME.		IN HEIGHT.				Number of Stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.			Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H.W.	L.W.	H.W.	L.W.	H.W.	L.W.		H.W.	L.W.	H.W.	L.W.	H.W.	L.W.
1909	6	85	86	97	97	97	98	3	61	59	69	65	93	92
1910	6	81	83	98	98	95	96	3	57	52	63	71	89	94
1911	6	84	84	98	99	97	98	3	65	51	68	66	90	90
1912	6	82	82	97	98	97	98	4	70	58	74	62	94	91
1913	6	83	82	97	97	98	99	4	68	55	70	58	94	88
1914	6	77	79	96	97	98	98	3	75	67	71	55	92	84
1915	6	82	82	98	98	96	96	3	76	66	73	67	94	92
1916	6	81	82	96	97	96	99	3	81	68	73	62	93	87
1917	6	75	72	96	98	96	97	3	78	65	69	64	92	88
1918	6	83	82	97	97	97	96	3	76	63	66	65	90	89
Average of ten years	...	81	81	97	98	97	98	...	71	60	70	64	92	90

50. No. 17 Party.—Levelling.—Three double detachments were employed during the past season on the levelling operations mentioned below.

(a).—In the Punjab.

Revisionary levelling by one double detachment from Pathānkot along the Pālampur road to the Chambi bridge and then along the bridle road *viâ* Kotwāli Bāzār (Dharmsāla) and McLeodganj Bāzār to Dharmkot hill.

This revision was undertaken in order to ascertain whether the severe earthquake of 1916 had caused any measurable change in the height of Dharmsāla. No change was detected. The difference between the old levelling of 1910 and the new of 1919 was less than 3 inches, a quantity which does not much exceed the probable error of the result.

The out-turn amounted to 56 miles of simultaneous double levelling: 9 primary and 65 secondary bench-marks were reconnected.

(b).—In Mesopotamia.

New levelling by two double detachments was carried out as follows:

(1) From Basrah to Nāsiriyah, along the railway, thence northwards *viâ* Samāwah to Hillah along the Hillah branch of the Euphrates, and finally, leaving the Euphrates, to Baghdād.

(2) From Baghdād to Kut-al-'Amarah and thence to Shaikh Sa'ad where a junction was made with a good line run in 1916-17 up the Tigris from Basrah by a party of levellers sent from India by the Public Works Department.

(3) From Kut-al-'Amarah *viâ* Hai along the Shatt-al-Gharrāf to Suwaij and thence by road to Nāsiriyah.

(4) From Baghdād to Ramādi *viâ* Feluja.

(5) From Baghdād to Table Mountain along the railway line

(6) From Baghdād to Baiji (Rail head) along the railway line.

The out-turn including branch-lines, amounted to 956 miles of simultaneous double levelling. The heights of 26 primary (Standard), 406 secondary and 467 tertiary bench-marks were determined.

This levelling was undertaken at the request of the Director of Irrigation, Mesopotamia, to serve as a frame-work on which the several schemes of irrigation emanating from the Tigris and the Euphrates could be based, but should geodetic operations be undertaken in Mesopotamia, these lines of levels will be of value.

51. No. 19 Party.—Base Line Operations.—No work was undertaken by this party during the year under report. The officers and establishment from time to time posted to it for administrative purposes were employed on miscellaneous work.

MAGNETIC SURVEY.

52. No. 18 Party.—Magnetic.—The magnetic observatories at Dehra Dūn and Toungoo were inspected by the Officer in charge during the field season and a complete set of observations was taken at each for the comparison of instruments. The Alibāg and Kodaikānal observatories, under the Meteorological Department, were also visited for the same purpose.

No field observations were taken during the year.

Three detachments will be employed in 1919-20 in taking magnetic observations at the 75 repeat stations in India, Burma and Ceylon in order that reliable values of the annual changes in the magnetic elements may be obtained after 1915 in which year observations were last taken at these stations. The results will be used in revising the present data and maps.

Special observations. Observations of the three magnetic elements were taken at the Dehra Dūn observatory on the 28th, 29th and 30th May 1919, in response to an appeal by Dr. L. A. Bauer, Director of Terrestrial Magnetism of the Carnegie Institution of Washington, to magnetic observatories in every country for co-operation in special simultaneous magnetic observations in connection with the Total Solar Eclipse of May 29, 1919. No unusual changes were noticed in the magnetic elements during the three days' observations at Dehra Dūn, but even a result of this nature will no doubt be of use to Dr. Bauer in his investigation of the effects of the eclipse on the Earth's magnetism.

Publication of the results of the Magnetic Survey. The publication of the results of the Magnetic Survey from 1901 to 1915, reduced to epoch 1909·0, has been unavoidably delayed. The printing is now, however, almost completed and it is hoped to publish the volume very shortly.

The reduction of the observations of the detail survey and the investigation of the results in disturbed areas are being proceeded with.

The Magnetic elements at observatories.—The computation and tabulation of the provisional values of declination, dip, horizontal force and vertical force for the three observatories (Dehra Dūn, Toungoo and

Kodaikānal) for 1918 have been completed; the mean values of these elements for the year 1918 derived from all days, excluding those of great disturbance, are given in the table below:—

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1918.

Observatory.	Latitude & Longitude	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 14 49·6	E 2 1·4	0·32980	0·32782
Toungoo ...	18 55 45 N 96 27 3 E	N 23 8·4	W 0 16·5	0·39067	0·16696
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 30·3	W 1 39·2	0·37694	0·02969

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

53. Brief reports of the work carried out during the year under review in the five offices administered by the Map Publication Office are given in paras. 55 to 59.

All these offices have continued to work under war conditions throughout the year; the requisitions by the Army for maps, &c., have been even larger than they were in the previous year, and the demand for instruments has remained much above the normal.

No additions have been made to the personnel of any of these offices except the Mathematical Instrument Office, and it is satisfactory therefore to record the fact that the abnormal amount of extra-departmental work has been carried out with little diminution of the ordinary out-turn of departmental mapping, &c.

54. The classes of maps for the publication of which the Head Quarter Offices are responsible are as follows:—

(*a*) Topographical maps on the scale of 1 inch = 1 mile.
(*b*) Topographical maps on the scale of ½ inch = 1 mile.
(*c*) Topographical maps on the scale of ¼ inch = 1 mile.
(*d*) Geographical maps on the 1:1,000,000 scale (about 1 inch = 16 miles).
(*e*) Geographical maps on the 1:2,000,000 scale (about 1 inch = 32 miles).
(*f*) General maps on smaller scales.
(*g*) Special maps.

The progress made in the publication of each of these classes is detailed below:

(a) **Topographical maps on the scale of 1 inch = 1 mile.**—During the year 57 modern sheets have been published. This is a small increase on the number published during the previous year.

Index map No. 2 at the end of this report shows the progress made in the publication of the modern one-inch public sheets, and the following table gives the annual output of these sheets since the modern topographical surveys were begun:—

Years of Publication.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	45	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
1915-16	85	69	50	204
1916-17	23	40	22	85
1917-18	18	12	13	43
1918-19	**32**	**19**	**6**	**57**
Total Published ...	676	454	449	1,579
Probable number of 1-inch sheets which will not be published owing to the area covered by them being included in the programme for survey and publication on the ½-inch scale ...	911	564	473	1,948
Approximate number remaining for publication ...	565	1,011	1,115	2,691
Approximate number of public 1-inch sheets in India ...	2,152	2,029	2,037	6,218

5 one-inch sheets of those surveyed during 1915-16, 31 one-inch sheets of those surveyed during 1916-17, and 22 one-inch sheets of those surveyed during 1917-18 remain to be published. Four one-inch sheets of those surveyed during the year under report have also been received for publication before 30th September 1919.

In addition to the above, preliminary editions (in colours) of 24 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision. No new "Village boundary" editions of modern one-inch sheets have been published for Local Governments.

59 modern one-inch, 10 preliminary editions of one-inch, and 45 old style one-inch sheets have been reprinted during the year.

(b) **Topographical Maps on the scale of ½ inch=1 mile.**—Index map No. 3 at the end of this report shows the progress made in the publication of the modern half-inch public sheets. This series now forms the *tactical* map of India, having taken the place of the quarter-inch maps in this respect. It was commenced in 1914; most of the sheets published up to date are reductions from the one-inch map, but others are from direct half-inch surveys.

The following table gives the annual output of these sheets:—

Years of Publication.	Number of ½-inch sheets published.		
	Drawn from component one-inch sheets.	Surveyed on half-inch scale.	Total.
1914-15	...	1	1
1915-16 ...	21	4	25
1916-17 ...	50	6	56
1917-18	59	6	65
1918-19	**26**	**4**	**30**
Totals	156	21	177
Approximate number of half-inch sheets in India	.....		630

20 half-inch sheets of those drawn in 1915-16, 3 half-inch sheets of those drawn in 1916-17, and 1 half-inch sheet of those drawn in 1917-18 remain to be published.

In addition to the above, preliminary editions (in colours) of 13 half-inch sheets, prepared from old half-inch material, have been published during the year.

3 modern public half-inch sheets and 5 old style half-inch sheets have been reprinted during the year.

(c) **Topographical maps on the scale of ¼ inch=1 mile.**—These maps are prepared in "degree" sheets which include 1° of latitude and 1° of longitude, *i.e.*, the area covered by 16 one-inch sheets, or four half-inch sheets.

The production of these maps is still delayed owing to the more urgent work on those of the half-inch scale.

Index map No. 4 at the end of this report shows the progress made in the publication of the modern quarter-inch public sheets.

The following table gives the annual output of these sheets:—

Years of Publication.	Number of "Degree" Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12 ...	2	1	4	7
1912-13	3	1	1	5
1913-14	8	3	2	13
1914-15	1	3	3	7
1915-16	...	1	4	5
1916-17	1		3	4
1917-18			1	1
1918-19 ...		**3**	**8***	**11**
Totals	11	12	26	53

In addition to the above, 10 modern public quarter-inch sheets have been reprinted during the year.

9 "degree" sheets have been prepared in No. 1 Drawing Office from the old engraved quarter-inch Atlas sheets, brought up to date and published (in black only) as provisional issues; and 5 of such sheets which were published previously have been reprinted during the year. These provisional "degree" sheets, including those in hand, now cover practically the whole area of India for which modern "degree" sheets are not likely to be available for some time.

(d) **Geographical Maps on the 1:1,000,000 scale.**—(*i*) **The "India and Adjacent Countries" Series** (*Vide* Index map No. 5).—During the year 2 new sheets of this series have been published, 2 sheets have been modernized and republished to supersede old editions, and 11 sheets have been reprinted.

(*ii*) **La Carte Internationale du Monde.**—(*Vide* Index map No. 6).—A full description of the genesis of this series was given in the General Report for 1913-14. No map of this series has been published during the year; 5 sheets have been published up to date.

(e) **Geographical Maps on the 1:2,000,000 scale.**—(*Vide* Index map No. 7).—No new map of this series was published during the year, but 2 sheets have been reprinted. Experiments to determine the most satisfactory method of engraving and reproducing the new maps of this series (which will eventually supersede the Map of India on the scale 1 inch = 32 miles) have been practically completed.

(f) **General Maps on smaller scales.**—The engraved plates of all these maps have been corrected and brought up to date as far as possible during the year.

(g) **Special maps.**—The annual edition of the Railway Administration map (on the scale 1 inch = 64 miles) and a new provincial map of the Punjab (on the 1:1,000,000 scale) have been published during the year; two provincial maps and the Railway, Canal and Road map of India (on the scale 1 inch = 32 miles) have been reprinted.

Numerous special maps have also been prepared and printed for the Army, for Local Governments and for other departments.

"Town Guide" maps, on the scale 12 inches = 1 mile, of several of the larger Indian cities are under preparation; 2 sheets of the Calcutta-Howrah "Town-guide" map (which will be contained in 16 sheets) have been published during the year.

55. Map Record and Issue Office.—No changes of any importance have been made in the organisation of this office during the year.

The amount of work carried out has been growing steadily every year, and more especially since 1914. The increase during the present year is very much greater than ever before; it has been caused partly, as in previous years, by large issues of maps to the Army, and partly by the fact that all extra-departmental publications have been issued throughout the year by this office, instead of direct from the Photo.-Litho. Office, as in previous years.

It is satisfactory to note that, despite the untimely death (in April 1919) of one of the Assistant Map Curators and the strain of the past five years' work on the whole staff, to which no additions

have been made during the war, all the urgent demands of the Army during the year have been met without delay.

It has not been possible to complete entirely the new system of recording all issues of maps from the *Print Section* of the office. Ledgers have now been compiled for all modern maps, but stock has yet to be taken of all maps, on various scales, published in old style from surveys prior to 1905.

Fair progress has, however, been made in the *Original Section* of the office during the year in card-indexing the receipts and issues of the records under the new system.

Details of the work of the office in connection with all Survey of India maps, termed "Departmental", and with all other maps, plans, charts and illustrations prepared for and supplied to departments other than the Survey of India and to the public, termed "Extra-departmental", have been sub-divided in this year's report and are shown separately in the subjoined tables of (1) maps issued and of (2) maps received from the Printing Offices.

Issues.—From Map Record and Issue Office, 1918-19.

Year.		On Book Debit (to Government Officials).		On Cash Payment (to Private Individuals and Map Agents).		Free Issues (Departmental and to India Office)		TOTAL.	
		Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.
1918-19	Departmental.	386,972	2,35,413	59,910	16,000	37,204	32,539	484,005	3,13,961
	Extra-departmental.	1,840,038	1,51,672	44,303	1,654	...	...	1,881,341	1,53,326
	Total	2,227,010	3,87,085	101,222	47,663	37,204	32,539	2,365,436	4,67,287
1917-18	Total	795,810	2,12,861	39,183	35,795	48,550	39,382	883,543	2,88,038
1916-17	Total	578,396	2,65,568	66,149	41,670	40,700	37,160	685,296	3,44,398

Table IV.—Publications received in Map Record & Issue Office, 1918-19.

A.—From the Calcutta Printing Offices, (including the Engraving Office).

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	Reprints and New Editions.		
		DEPARTMENTAL.			
GENERAL MAPS.					*Rs.*
Maps of India	Various	.....	3	2,800	3,650
GEOGRAPHICAL MAPS.					
Map of India	1°-32 miles	.....	1	200	1,800
Southern Asia Series	1:2,000,000	.....	2	3,000	9,000
India and Adjacent Countries Series	1:1,000,000	2	13	9,461	9,461
La Carte Internationale du Monde	1:1,000,000	.....	.....	.....	.....
TOPOGRAPHICAL MAPS.					
Quarter-inch Modern	1°-4 miles	6	10	34,155	34,155
Do. (Prely.)	1°-4 miles	5	.....	2,960	2,715
Do. (Provl.)	1°-4 miles	9	5	2,610	2,610
Half-inch Modern	1°-2 miles	30	3	26,345	25,804
Do. (Prely.)	1°-2 miles	.....	.....	.....	.....
One-inch Modern	1°-1 mile	57	59	82,532	82,032
Do. (Prely.)	1°-1 mile	24	10	17,397	17,397
Old Style sheets	Various	.....	76	13,085	19,030
SPECIAL MAPS.					
District Maps ...	1°-4 miles	.....	...	.....	.....
Administration Report Maps ...	1°-8 miles	.....	6	320	122
Provincial Maps	Various	1	2	1,300	1,756
Plans of Cities and Cantonments ...	Various	2	2	380	440
Index Maps	Various	3	6	14,950	3,224
Miscellaneous Maps	Various	54	44	46,995	28,088
Total	.....	193	242	258,490	2,41,28
		EXTRA-DEPARTMENTAL.			
Maps	Various	153	53	316,700	84,024
Plans and diagrams ...	Various	154	29	623,300	40,719
Illustrations ...	.....	64	6	243,301	11,599
Miscellaneous ...	.....	42	79	703,815	17,958
Total ...	.....	413	167	1,887,116	1,54,300
Grand Total	.....	606	409	2,145,606	3,95,584

B.—From the Trigonometrical Survey Office, Dehra Dun.

Various	...	5	17	1,043	1,683

C.—LETTERPRESS.

1. Survey of India General Report, 1917-18. *Price Rs. 2 or 2s-8d.**
2. Records of the Survey of India, Volume XII (1919) Notes on Survey of India maps and the modern development of Indian Cartography. *Price Rs. 3 or 4s.**
3. Hand-Book of Topography, Chapter X, Map Reproduction, Second Edition, 1919. *Price As. 4 or 4d.**

* Sterling prices should be increased by 50 per cent.

56. No. 1 (Head Quarters) Drawing Office.—This office is organised in six sections, each section being under its own supervising officer.

(1) *The Compilation Section.*—Deals with "La Carte Internationale du Monde au 1,000,000," with all "Geographical" maps on scales smaller than the 1:1,000,000, and with miscellaneous work.

(*a*) Of the seven sheets of "La Carte Internationale du Monde" which were in hand at the end of the previous year, five sheets have been completed and sent to press; colour proofs (from the engraved plates) of the remaining two sheets are under examination. No new sheets of this series have been taken up during the year.

(*b*) Of the new maps of the Southern Asia Series, on the 1:2,000,000 scale, the preparation of patterns for engraving the outline plates of four sheets has been continued throughout the year. A revised table of the lettering to be engraved on this new series has been completed.

(*c*) The most important "Miscellaneous" maps dealt with by this section during the year have been "Town Guide" maps. The fair-mapping of four of these maps was in hand at the end of the previous year; of these, two have been completed and sent to press, the third has been transferred to a special party for revision in the field, and the fourth is awaiting return of the corrected proofs.

During the year, print originals of three additional "Town Guide" maps were completed and sent to press, and a preliminary Type table for Town Guide maps was also compiled, drawn and sent to press. Corrected patterns and new colour guides have been prepared for a reprint of the 6-inch (engraved) Map of Calcutta.

(2) *The "One-Millionth" Section.*—Deals with all maps of the "India and Adjacent Countries" Series, on the 1:1,000,000 scale.

(*a*) Engraved Editions (original and modernised). Of the 13 sheets which were in hand at the end of the previous year, 7 have been completed and sent to press, working patterns for engraving the plates of 3 sheets, and the preliminary compilation patterns of the remaining 3 sheets, are in hand. The preliminary compilation pattern of one extra sheet has been taken up during the year.

(*b*) Helio Editions (Original and Reprint). The fair-mapping of three original sheets was in hand at the end of the previous year. One of these has been sent to press for reproduction and supply of preliminary proofs, work on the remaining two sheets is in progress.

No other original sheets have been taken up during the year.

The fair sheets of 5 previously published sheets have been corrected for reprint and sent to press.

(3) *The Quarter-inch Section.*—Deals mainly with the fair-mapping of quarter-inch sheets, compiled from surveys on any scale executed prior to 1905, for publication in modern style either in colours (Preliminary Editions), or in black, or black and brown (Provisional Issues).

(*a*) At the end of the previous year, fair-mapping of 9 quarter-inch sheets was in hand (six "Preliminary Editions" and three "Provisional Issues").

The drawing of seven of these sheets has been completed during the year; considerable progress has been made on the other 2 sheets.

During the year under report, 20 quarter-inch sheets, which were under preparation in the *Mapping and Reprint Section* for publication as "Provisional Issues," were transferred to this section for completion. 4 of these sheets have been fair-mapped for publication as "Preliminary Editions," but have not been sent to press yet; work has been stopped altogether on 2 sheets; and the remaining 14 sheets have had to be put aside for the time being.

In addition to the above, work has been started during the year on two quarter-inch sheets, for publication as 'Provisional Issues,' and fair-mapping of both is in progress.

(*b*) The 14 half-inch sheets which were in hand during the previous year, from old Sind Survey sheets, have been completed and sent to press during the year, for reprint in modern style as "Preliminary Editions".

(4) *The Mapping and Reprint Section.*—Deals mainly with the corrections of fair sheets of topographical maps (both from modern surveys and from surveys executed prior to 1905) for reprint, and with the fair-mapping required for special maps (including extra-departmental) on all scales.

(*a*) (*i*) The fair sheets of 148 previously published topographical maps (105 modern and 43 old) have been corrected and brought up to date and sent to press for reprint during the year. Work is in progress at the end of the year under report on 100 sheets (75 modern and 25 old).

(*ii*) The fair sheets of 33 new topographical maps drawn by field parties or by other drawing offices, have been corrected (on receipt for publication or at proof stage) during the year, before final publication.

(*iii*) "Press Order Proof" corrections have been inserted on the originals of 101 new topographical maps, after publication.

(*b*) 22 "Provisional Issue" degree sheets were prepared from old atlas sheets and sent for publication during the year.

(*c*) Fair sheets (either original drawings or print originals) of 25 special maps, on various scales, have been drawn for the Army, other Government departments, &c., and sent to press.

There has been little or no diminution during the year of the usual miscellaneous work of all other descriptions (including extra-departmental work) carried out by this section.

(5) *The Office Copy Section.*—Maintains records of all additions and alterations to the details shown on all published maps of all scales, for incorporation in new editions or reprints of such maps.

(*a*) These corrections and additions have been made to 2,542 existing "office copies" of maps of all scales during the year. 355 fresh "office copies" of newly published or reprinted maps have been prepared.

(*b*) The miscellaneous work of this section includes the checking and recording of the areas contained in all one-inch and half-inch maps received by the Map Publication Office for publication, the supply of certified copies of original records both to official and private applicants, and correspondence relating to Revenue Survey maps.

(6) *The Examining Section.*—Examines the majority of the sheets which are fair-mapped by the other sections of this office, and scrutinizes a large number of sheets which are fair-mapped elsewhere, before publication.

296 "cases", affecting 412 maps on various scales, have been examined and passed during the year.

The amount of miscellaneous work dealt with by this section, in connection with the fair-mapping of the whole department, is exceedingly large and its nature is too diverse to specify in detail.

57. Engraving Office.—(1) *Engraving Section.* (*a*) As in the previous year, most of the engravers have continued to be employed during the year under report on new or modernized editions of maps of the "India and Adjacent Countries" Series and of "La Carte Internationale du Monde", both on the 1:1,000,000 scale.

Of the former series all four plates of all the seven sheets in hand have been completed; of the latter series all four plates of five out of the seven sheets in hand have also been completed, the remaining two sheets having reached proof stage.

(*b*) No work has been done during the year on the plates of any of the sheets either of the Southern Asia Series, on the 1:2,000,000 scale, or on the new Map of India on the 1:4,000,000 scale.

A good deal of preliminary work, however, has been carried out in connection with the former series, whereby it is hoped considerably to expedite the engraving when the revised patterns of the sheets which are now being compiled are received.

(*c*) Periodic corrections have been carried out on the plates of all the General (engraved) Maps of India on smaller scales than the 1:2,000,000 and of all Index charts.

The four plates of the 6-inch Map of Calcutta have been corrected and brought up to date for reprint.

The combined outline and contour plates of quarter-inch sheet 38 N which were engraved in 1915 have been corrected and brought up to date, and art paper prints of each have been supplied to the Photo.-Litho. Office for reproduction by heliozincography. This is for experimental purposes.

Miscellaneous work is mostly extra-departmental and includes the engraving of a large War-memorial brass plate, of various kinds of scales required by the Army, and of titles on a considerable number of photo-gravure plates.

(2) *Printing Section.*—25,544 impressions were pulled during the year compared with 42,158 during the previous year, on the same number of machines. 42 per cent. of the impressions pulled during the year were extra-departmental orders, such as photogravures, commission forms and certificates.

Interesting experiments have been carried out to ascertain whether copies of the "Political Edition" of geographical and general engraved maps could be printed in colours, if necessary, by this section direct from the copper plates. Although it was proved that this could be done successfully, it was decided, for other reasons, to adhere to the present methods of printing such copies from transfers-to-zinc plates in the ordinary litho. machines.

As a result of this experiment however, all multi-plate engraved maps are now proved in colours, which shortens the duration and increases the accuracy of examination.

58. Photo.-Litho. Office.—The *Litho.* out-turn for the year under report is slightly smaller than the record out turn of the previous year, but is considerably greater than that of any other year (*vide* Table B). Very urgent demands by the Army for maps resulted in two new "records" being made for the monthly out-turns of June and July 1919; this was accomplished by the employment of a large amount of overtime.

The two rotary off-set machine presses which were ordered last year having proved unobtainable, other suitable machines are being selected in England. These are required to replace two very old machines which cannot deal efficiently with colour work.

Improvements to plant comprise the laying of floor rails in the studio, to enable No. 1 camera to be swung round for use without a reversing prism, and the building of a large drying-box for use in the *Powder Process Section*. The entire renewal of the wiring of the electric lighting and power circuits and the installation of new switchboards throughout the office is also in hand.

No new processes have been introduced during the year, but the methods of photographing layer and hill-shaded originals have been improved.

Experiments are also being made with a view to supersede the slow and laborious method of "transfer" from engraved copper plates to zinc by the photographic reproduction of art paper prints from the copper plates, and it is hoped that these will prove successful.

The "Powder Process", which was introduced last year for making any number of reversed copies of a negative, has continued to be most successful, not only in reducing the cost and improving the quality of reproduction but also in relieving work in the studio.

The following table summarizes briefly the out-turn of the *Photo. Branch* during the past three years:—

	1916-17.	1917-18.	1918-19.
Negatives	4,778	5,500	4,190
Zinc Plates ...	7,496	8,426	7,227
Photogravure Plates			
Half-tone blocks ...	776	880	554
Line blocks			

In the *Litho. Branch* the machines and handpresses printed a total of 1,828,240 copies of maps and diagrams during the year under report; the majority of these were printed for the Army.

Details of all the new publications and subsequent new editions or reprints of public maps printed during the year are given in Table IV on page 29.

A comparison of the work done and its cost during the past three years is given in the two tables and diagram below:—

Out-turn of Photo.-Litho. Office during 1918-19.

TABLE A.

1	2	3	4	5	6
Year.	*Cost of office.	Value of out-turn at cost-rates.	Number of maps printed.		
			Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*			
1916-17	1,79,661	3,47,271	793	3,391	4,184
1917-18	2,08,784	4,34,124	817	3,812	4,629
1918-19	**2,21,218**	**4,54,243**	**637**	**4,203**	**4,840**

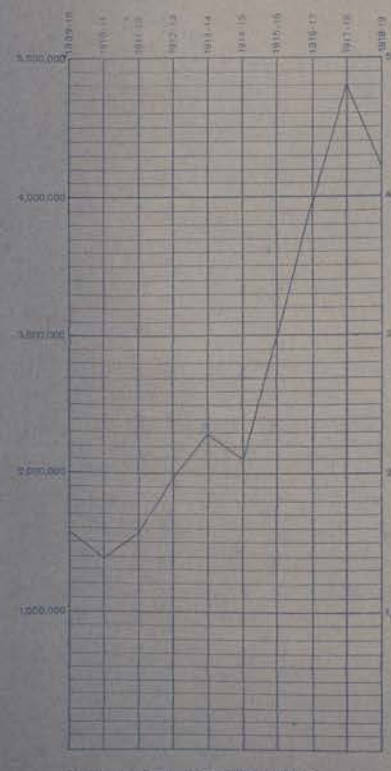
* Does not include cost of chemicals, paper, &c., obtained from England (Rs. 1,85,633 in the year under report), and excludes the amount recovered directly in cash or book debit for work done (Rs. 20,324 in the year under report).

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	Type Section Out-turn.		
				Pages or items published.	Copies printed.	Impressions pulled.
1916-17	3,954,954	115,486†	639,838	8,216	1,311,014	2,051,347
1917-18	4,796,813†	224,903	1,193,418	7,476	942,811	1,677,147
1918-19	**4,248,913**	**183,413**	**1,151,678**	**5,577**	**1,233,211**	**1,829,380**

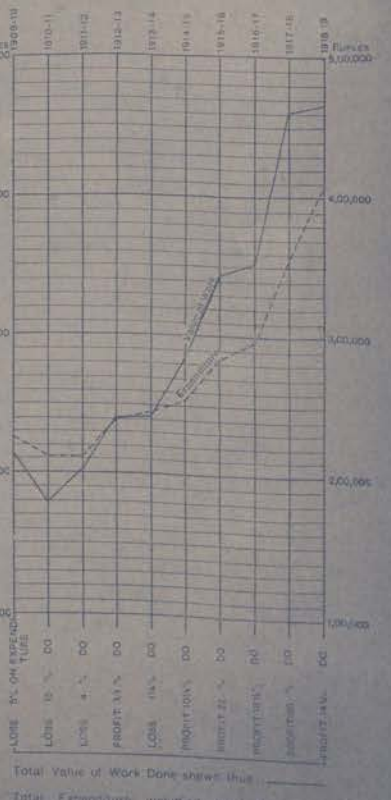
† Incorrectly printed as 5,486 and 4,796,81 in the General Report, 1917-18.

DIAGRAM SHOWING OUTTURN OF THE LITHO BRANCH during the last ten years.



Number of impressions pulled in Litho Branch shewn thus .....

DIAGRAM SHOWING PROFIT AND LOSS on the working of the whole office during the last ten years.



Total Value of Work Done shewn thus _____

Total Expenditure including cost of English stores, &c. shewn thus - - - - -

59. Mathematical Instrument Office.—During the year from 1st April 1918 to 31st March 1919, there was some decrease in the demands made on this office (*vide* item 1 in para. 2), and an increase in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 1,21,573 and Rs. 39,762 against a profit of Rs. 1,55,859 and Rs. 50,741 in 1917-18.

2. Below are given the usual comparative figures for the last 3 years:—

	1916-17.	1917-18.	1918-19.
	Rs.	*Rs.*	Rs.
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	5,52,655	8,88,658	7,64,795
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	58,423	53,133	50,904
3. Value of instruments received from Government Officers when no longer required.	77,147	85,209	1,33,730
4. Book value of the stock of instruments, &c., in Serviceable Stores.	4,73,155	3,92,268	4,22,818
5. Book value of the stock of instruments, &c., in Repairable Stores.	1,15,805	1,04,394	1,10,554
6. Total value of work done in the Workshop ...	2,99,531	3,41,627	4,35,023
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	1,76,119	1,85,737	2,17,342
8. Value of instruments purchased locally	1,09,039	4,30,336	2,72,462
9. Value of instruments and materials obtained from England through the Director General of Stores.	1,01,744	66,380	67,174
10. Average No. of employees and their pay ...	No. 417 Rs. 1,02,664	No. 504 Rs. 1,33,719	No. 556 Rs. 1,63,759

3. During the year the stock of all the three stores (the Serviceable, the Repairable and the Material Stores), was twice taken, and the discrepancies noticed have been adjusted.

II.—DEHRA DÚN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

60. Computing Office.—The notable feature of the year's work is the publication of Professional Paper No. 17—"Investigations of Isostasy in Himálayan and Neighbouring Regions" by Colonel Sir Sidney Burrard, K.C.S.I., R.E., F.R.S. An endeavour has been made in this paper to solve the geodetic problem of the Indo-Gangetic trough.

The adjustment of the pendent portion of the Burma Coast Series which extends to the south of latitude 18° and of the Bangkok Series has been carried out. The heights of the principal triangulation in Burma have also been adjusted.

A second edition of Levelling pamphlet 57 and an Addendum to Levelling pamphlet 56 have been published. A reprint of Levelling pamphlet 53 is in hand and well advanced through the press.

Chapter III (1914) of the Hand-Book of Topography is being rewritten and will be ready for publication in the course of the next year. Computation forms are being remodelled and adapted to paper of foolscap size.

158 requisitions for data from departmental and non-departmental officials were complied with.

61 Triangulation pamphlets covering 202 degree sheets were published and issued in the course of the year.

For purposes of investigation a large amount of computation in connection with Isostasy was carried out.

Type Printing Section.—The following publications were printed during the year:—

1. Records of the Survey of India, Volume XIII, 1917-18.
2. Professional Paper No. 17.
3. Mesopotamian Levelling pamphlet.
4. Levelling pamphlet 57 (2nd edition, revised) and Addendum to Levelling pamphlet 56.
5. Triangulation pamphlets covering 220 degree sheets.
6. Tables of reduced results of magnetic observations by No. 18 Party.
7. Extracts from Auxiliary Tables for use of explorers, a glossary of Tibetan names and a large amount of miscellaneous work.

Observatories.—Meteorological observations were continued as usual, and the Omori Seismograph was in operation throughout the year.

Photographs of the sun were taken on 324 days, the sun being obscured on the remaining days of the year.

Preservation of Trigonometrical Stations.—825 stations were repaired by district officers at a cost of Rs. 4,318-9-2. Out of 359 districts from which reports were due, 24 failed to make returns.

61. No. 2 (Dehra) Drawing Office.—During the year under report the work in this office was carried out by five sections.

(1) *The Triangulation Chart and Cantonment Plan Section.*—In addition to the ordinary work of this section, 17 miscellaneous maps and charts, 3 Levelling charts and 5 Index charts were prepared and sent to press.

(2) *The Compilation Section.*—The rough compilation on the scale of 1 inch=12 miles of 4 sheets up to East Longitude 108°, and the rough compilation of another sheet on the 1/M scale, were taken in hand during the current year; 4 sheets on the 1/M scale were sent to the Superintendent of Map Publication, for publication, and 9 sheets are still in hand, 4 sheets with hills on the 1/3M scale are now nearly completed and will be sent for publication shortly.

The rough compilation of the northern half of the Brahmaputra sheet of the Southern Asia Series was completed and sent to the Superintendent of Map Publication, for publication. The rough compilation of the North Tibet sheet of the Southern Asia Series was taken in hand during the year.

(3) *The Stein Section.*—The fair-mapping of 31 sheets of Sir Aurel Stein's explorations in 1900-01, 1906—08 and 1913—15 has been continued; of these 19 were completed and sent to press; the remaining 12 sheets are in hand or awaiting scrutiny by Sir Aurel Stein before being sent to press. Of the sheets sent for publication, 27 are still in the "colour proof" stage.

The fair-mapping in this section will be completed shortly, after which the section will be employed on the examination of colour proofs.

(4) *The Half-inch Section.*—The fair-mapping of 4 sheets *viz.*:—63 F/N.W., F/N.E., F/S.W., F/S.E., taken up last year was completed and they will be sent to press when the final corrections are carried out. The personnel of this section has now been absorbed into the other sections and the section done away with.

(5) *The Examination Section.*—This section was organised in March 1919 and has since received 93 cases, of which 79 have been disposed of, leaving a balance of 14 cases in hand.

This section was also employed in preparing numerous diagrams and charts to illustrate reports.

In addition to the above, 22 pupil draftsmen were instructed in drawing, rapid style hand printing, and the use of drawing instruments. Of these 22 pupils, 4 were sent to the Superintendent, Southern Circle, 10 have been given employment in this office and 8 are still undergoing training.

The following is the summary of the work of the office during the year 1918-19:—

Class of map.	Balance of sheets on 1st October 1918.	No. of sheets received in 1918-19.	Sheets sent for publication in 1918-19.	Sheets remaining in hand on 30th September 1919.	Remarks.
Geographical maps, scale 1/M (Rough compilation).	.....	5	.....	5	Including one sheet recompiled for engraved edition.
Geographical maps, scale 1/4 M (Rough compilation).	.....	4	.....	4	For engraved edition.
Geographical maps, scale 1/2 M (Brahmaputra sheet, northern half. Rough compilation).	1	.....	1	...	
Geographical maps, scale 1/2 M (Southern Asia Series, North Tibet sheet. Rough compilation)	.....	1	.....	1	
Geographical maps, scale 1/M (Fair sheets).	13	...	4	9	Includes 3 rough compilations from previous report which are now being fair-drawn.
Geographical maps, scale 1/3 M (Fair sheets).	4	.....	.....	4	Outline and Hill sheets, nearly completed.
Geographical maps, scale 1/M (colour guides).		9	9		
Sir Aurel Stein's explorations in Chinese Turkistán and Kansu, in 1900-01, 1906—08 and 1913—15, for publication on 1/2 M scale.	37*	.....	19†	12	*33 sheets remained over from last year, but 2 sheets have been incorporated with other sheets when the sheets were all readjusted. †Of all the sheets sent to press, 2 are still in "Proof in colours" stage.
Triangulation Charts, scale 1 inch = 1 mile.		3	3		
Triangulation Charts, scale 1 inch = 4 miles.	14	35	34	15	
Triangulation Charts, scale 1 inch = 8 miles.	5	10	13	2	
Triangulation Charts, scale 1 inch = 16 miles.	3	6	8	1	
Levelling Charts, scale 1/M	.....	4	4		Including one of Levelling in Mesopotamia on scale 1/2 M.
Cantonment plans for publication	...	61	61		Sheets of 22 cantonments proved and published.
Cantonment plans for corrections	64	58	70	52‡	Corrections of 57 cantonments for 1918 carried out both on originals and office copies. ‡Includes corrections of 18 cantonments for 1919.
Cantonment plans (colour guides)		16	6	10	In hand.
Half-inch sheets	4	...	...	4	Will be sent to press shortly.
Miscellaneous Extra-departmental maps and charts and diagrams.		27	27		Including Mayo Salt Mine maps, sketches of chambers and charts.
Maps of Mesopotamia ...		2	2	.....	Proofs examined and sent to press.
Index Charts ...	.....	5	5		

Photo-Zinco. Section.—During the year 1918-19, the work undertaken comprised :—

Cantonment Maps.
Indexes and Triangulation Charts.
Forest Maps.
Sir Aurel Stein's Maps.
Miscellaneous Maps.
Extra-departmental Maps.

In the year under review, the small litho. machine was received back from Baghdād, but in the meantime a second-hand machine had been purchased from England and erected in its place. A Reproducing Section (comprising 5 technical hands and khalasis) was formed and placed at the disposal of the Superintendent, Northern Circle, for work with the North-West Frontier Survey Party at Peshāwar.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Cyanotype prints.
1916-17 ...	1,502	1,600	287,514	571
1917-18 ...	1,130	1,719	345,776	127
1918-19	**1,193**	**1,475**	**275,276**	**229**

62. Forest Map Office.—The classes of work entrusted to the four technical sections of this office were briefly described in last year's report; the distribution of the work has been continued on the same lines, and the progress made during the year under report is described below :—

(1) *The Drawing Section.*—The progress of this section for the year under report is shown in the table below :—

Class of map.	In hand on 1st October 1918.	Received during the year 1918-19.	Drawn and sent for publication in 1918-19.	In hand on 30th September 1919.	Published during the year 1918-19.	Total number of copies printed.
(*a*) ...	15	56	71	.....	74	18,300
(*b*) ...	71	58	66	63	52	
(*c*) ...	20	10	13	17	4	
(*d*) ...	9	62	57	14	17	
(*e*) ...	4	4	8	.....	6	
(*f*) ...	44	27	35	36	31	
(*g*) ...	.....	51	50	1	29	
TOTALS ...	163	268	300	131	213	18,300

(*a*) Reprints of Forest maps on various scales.
(*b*) Forest editions, on the scale of 2 inches = 1 mile, of modern cadastral maps.
(*c*) Maps of Forest Circles and Divisions.
(*d*) Maps to illustrate working plans, &c.
(*e*) Maps and diagrams to accompany Administration Reports.
(*f*) Forest maps from special surveys, mostly on the scale of 4 inches = 1 mile.
(*g*) Index and miscellaneous maps.

(2) *The Portfolio Section.*—Office copies of 1,152 maps and colour specimens of 112 maps were prepared, corrections on 657 sheets were completed, and 3,013 sheets were coloured by hand for issue. New racks for this section were built last year, and the sorting and re-arrangement of all office copies in these racks was completed during the year.

(3) *The Map Record Section.*—The number of maps, diagrams and other records, received for storage was 21,613; and 20,392 maps, &c., valued at Rs. 19,178 were issued. The relative decrease in the value, compared with the figures for last year, is due to the revised rates charged for maps of small sizes. Sales by book-transfer to Government departments amounted to Rs. 7,252 for 7,990 maps, &c., against Rs. 9,449 for 9,086 maps, &c., issued during the previous year. Cash sales to the public amounted to Rs. 3,310 for 5,558 maps, against Rs. 2,025 for 1,375 maps which were sold last year.

(4) *The Book-Binding Section.*—The section dealt with 264 volumes for the Forest Research Institute and 61 volumes for the Library of the Trigonometrical Survey, the value realized being Rs. 701, an increase of 187 volumes and Rs. 336 over the figures for last year; in addition 2,142 maps of various sizes were mounted on cloth for issue.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

63. No. 3 Drawing Office (Northern Circle).—During the year under report 14 one-inch sheets, out of the 29 previously surveyed, were fair-mapped by parties and after final examination have been submitted for publication. In addition to these, 1 one-inch sheet was brought up to date and completed to margin, while 4 other one-inch sheets were brought up to date, redrawn and completed to margin, in the drawing office for purposes of reprint.

Half-inch sheets compiled from published sheets of the modern one-inch and old style half-inch maps.—7 half-inch sheets drawn in the Circle drawing office were submitted for publication during the year.

On the basis of the one-inch maps published to 30th September 1919, there now remain for completion in the Northern Circle 117 half-inch sheets of the kind under consideration. Of this number, the fair-mapping of 23 sheets is in hand or has been started.

In addition to the above, there are 6 half-inch sheets partially incomplete owing to some of the component one-inch sheets, though surveyed, not having been submitted for publication.

Quarter-inch sheets compiled from the published sheets of the modern one-inch and half-inch maps (and old style maps).—During the year, 1 quarter-inch sheet was fair-mapped in the Circle drawing office and submitted for publication. The fair-mapping of 3 quarter-inch sheets is in hand while that of 2 others is in abeyance.

The material for 4 quarter-inch sheets is incomplete, owing to component one-inch, though surveyed, not having been submitted for publication; the published material for 23 further quarter-inch sheets is available for fair-mapping.

Special maps.—During the year 15 sheets of the Simla Extension Survey, scale 220 feet = 1 inch; 1 sheet of the Jutogh Cantonment, scale 40 feet = 1 inch; 1 sheet of the biennial survey of Delhi and vicinity, scale 4 inches = 1 mile and 3 of the Royal Artillery Practice Camp maps, scale 3 inches = 1 mile, were fair-mapped and submitted for publication.

Hill-shaded sheets.—38 hill-shaded sheets, of one-inch, half-inch and quarter-inch sheets and Royal Artillery Practice Camp Maps, were stump shaded and submitted for publication during the year.

Layer guides.—Nil.

Colour patterns and press order proofs.—During the year 59 press order proofs and colour patterns were prepared and submitted for publication.

Triangulation charts.—A special section was formed during the year under report to deal with this work which had fallen much into arrears. Considerable progress has been made in sorting and arranging all volumes and data, but as the major portion of the work has been of a preparatory nature, no out-turn figures can be given at present.

Miscellaneous.—The traverse plots of 16 *mauzas* in 33 sheets, scale 16 and 32 inches = 1 mile, of the Gondā district were prepared and the cost of preparation recovered from the Deputy Commissioner, Gondā.

For the purposes of reprint, the office copies of 77 one-inch sheets were corrected, brought up to date and submitted for publication during the year.

64. No. 4 Drawing Office (Southern Circle).—During the year, 25 one-inch sheets, 6 half-inch and 2 three-inch sheets, which had been surveyed and fair-mapped by parties were finally examined and submitted for publication. At the close of the year, all sheets surveyed in previous years had been submitted for publication, with the exception of two sheets, of which one requires further reference to the ground, the other has been received from the party and is now under final examination.

Half-inch sheets compiled from published sheets of the modern one-inch maps.—8 sheets were fair-mapped and submitted for publication, and a further 8 sheets, which had been fair-mapped by the parties, were finally examined and also submitted for publication. At the end of the year, one sheet was being fair-mapped in this office and 22 were being fair-mapped by the parties.

The number of half-inch sheets completely surveyed, but of which the component one-inch sheets have not yet been submitted for publication, is 5.

The number of half-inch sheets of which the component one-inch sheets have been sent for publication, but the fair-mapping of which has not yet been begun, is 10.

Quarter-inch sheets compiled from published sheets of the half-inch map.—The fair-mapping of 11 sheets is in hand, no sheets were completed and submitted for publication.

The number of quarter-inch sheets completely surveyed, but of which the component half-inch sheets have not yet been submitted for publication, is 10.

The number of quarter-inch sheets of which the component half-inch sheets have been sent for publication, but the fair-mapping of which has not yet been begun, is 4.

Special maps.—2 were examined and sent to press.

Hill-shaded sheets.—20 were prepared.

Layer guides.—One was prepared.

Colour patterns.—Were prepared for 38 sheets.

Triangulation charts.—None were prepared.

Photo.-zinco. work.—Number of reproductions 113
" " enlargements 110
" " reductions 202
" " Vandyke plates prepared ... 161
" " prints pulled 6,499

Miscellaneous.—19 two-inch maps of the Hyderabad Forest Reserves were examined.

The usual training in drawing was given to the pupil surveyors and the parties were assisted with draftsmen.

65. No. 5 Drawing Office (Eastern Circle).—During the year, 24 one-inch sheets and 1 half-inch sheet, drawn from recent surveys, were received in the drawing office from the parties of the circle. Of these, 3 one-inch sheets, as well as 7 one-inch sheets out of the 10 left over from previous year, were submitted for publication. 7 more have been scrutinised and got ready for submission. The remaining 18 sheets are under examination and further correction.

Half-inch sheets compiled from published sheets of the modern one-inch maps (and old style maps).—14 sheets, including 4 taken in

hand during the year under report, were under preparation in the Circle drawing office during the year. 11 other sheets were received from the parties of the circle during the year. These, and 3 sheets received prior to 1st October 1918, are being dealt with in the drawing office. 4 of these were received in an incomplete state as regards boundaries and heights and are now being completed in the drawing office.

On the basis of one-inch sheets published up to 30th September 1919, there now remain 62 half-inch sheets for drawing in the circle, of which 39 are under preparation in the drawing office and parties of the circle.

There are 17 half-inch sheet areas completely surveyed on the 1-inch scale, but of these areas, the component one-inch sheets had not been submitted for publication on 30th September 1919.

Quarter-inch sheets compiled from published sheets of the modern one-inch and half-inch maps (and old style maps).—2 sheets were received from the parties of the circle during the year, but both were in an incomplete state as regards heights and boundaries and are now being completed in the Circle drawing office.

10 sheets were in hand in the Circle drawing office during the year, work on one of which was held in abeyance, pending completion of further surveys now in progress in its area.

Material for the preparation of two quarter-inch sheets, from either one-inch or half-inch published modern sheets, was ready on 30th September 1919; but draftsmen were not available to draw them. Of 6 other quarter-inch sheets, the component one-inch sheets, but not half-inch sheets, had been published in modern style prior to 1st October 1919; and it is not proposed to take up their preparation till these half-inch components have been published.

There were also, on this date, 4 other quarter-inch sheets the whole areas of which have been surveyed in modern style on the scale of 1 inch = 1 mile, but of which the one-inch sheets have yet to be published; and of these too it is proposed to postpone the preparation pending publication of their half-inch components.

Hill-shaded sheets.—Material for 6 sheets (all one-inch) was received during the year and that for 25 sheets (one-inch, half-inch and quarter-inch) was left over from the previous year. Of these 31 sheets, shaded originals for 14 one-inch, half-inch and quarter-inch sheets were submitted during the year and those for 6 others have been completed and are ready for submission. This leaves a balance of 11 sheets in hand for next year.

The Layer guide of one quarter-inch sheet was prepared and submitted during the year.

Colour patterns and press order proofs.—Proofs for the preparation of colour patterns for 9 sheets were received during the year and those for 34 sheets were in hand on 1st October 1918. 17 of these were completed and finally submitted during the year and one was abandoned pending completion of further surveys and additions to the sheet; 9 others are ready for submission, leaving a balance of 16 sheets in hand in various stages of completion.

Triangulation charts.—The preparation of 4 degree triangulation charts was in hand in the circle on 30th September 1919.

66. No. 6 (Simla) Drawing Office.—As during the previous year this office was organized in 2 sections.

The *Army Section* has dealt with the preparation of maps and plans for the use of the Army in India while the *Survey Section* has

been employed on the preparation of trans-frontier maps on the one-millionth, quarter-inch and half-inch scales.

Most of the work of the *Survey Section* has consisted in redrawing in modern style, and sometimes to a reduced scale, the maps already existing, with the incorporation of such additional information of recent date as may have been available.

67. Bengal and Bihār and Orissa Drawing Office.—(*Imperial Standard Mapping Section*). The ordinary work of this office is the compilation (from modern revenue survey material and from "local series" maps) and fair-mapping of one-inch sheets, for publication in colours as preliminary editions pending their topographical revision.

During the year under report the whole strength of this office has not been employed, as in previous years, on this work: and fewer sheets have been completed and submitted for publication in consequence.

Of *Bengal* 12 new sheets have been fair-mapped and submitted for publication during the year.

Of *Bihār & Orissa* 2 new sheets have been fair-mapped and 8 sheets, previously published without hills, have been completed for republication of new editions with hills.

The additional work undertaken by this office during the year, on which a considerable portion of its strength was employed, has been the compilation and fair-mapping of a new "Town Guide" map of Calcutta-Howrah for publication in 16 sheets on the scale of 12 inches = 1 mile.

This new combined map is being compiled from the existing map of Calcutta on the scale of 16 inches = 1 mile, which has been brought up to date as far as possible, and from new drawings prepared from reductions of the recent survey of Howrah on the scale 50 feet = 1 inch.

Work on this map was started in October 1918. All 16 sheets were completed and submitted for publication, and 2 of them were published, before the end of the year under report.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

68. Northern Circle. *No. 1 Party.*—Three Royal Artillery Practice Camps were surveyed on the scale of 3 inches = 1 mile, *i.e.*, Baleli (near Quetta) 95 square miles, Pāli-pahāri (near Jhānsi) 61 square miles, and Killod (near Mhow) 72 square miles (*vide* also page 13).

The country round Baleli consisted of an open cultivated valley at an altitude of about 5,000 feet intersected by numerous water courses generally dry and included parts of the foot-hills of the two ranges forming the valley; that round Pāli-pahāri and Killod was mostly open, cultivated and undulating country with a few hills.

The fair-mapping of the Yāru-Bostān Camp left over from last year has been sent in for publication and the fair-mapping of the three new camps mentioned above will be completed shortly.

Details of the survey for "Town Guide" maps executed by this party will be found on page 18.

No. 2 Party.—At the instance of the Secretary, Public Works Department, Rājputāna, the survey on the scale of 24 inches to a mile was commenced of the hill station of Mount Abu and its extension as acquired on lease by Government from the Sirohi Darbār, comprising an area of some 5,500 acres in all. The cost of this survey is being borne by the Public Works Department, Rājputāna. The details of the work done up to date are given on page 18.

Details of the survey for "Town Guide" maps executed by this party will be found on page 18.

Sind-Sāgar Party.—During the year under report, the party was employed on rectangulation of the Sind-Sāgar Doāb in connection with the Punjab Government's Sind-Sāgar Canal and Colonization Project, in Miānwāli, Shāhpur, Jhang and Muzaffargarh districts.

The whole tract, approximate area 7,863 square miles, comprised in the scheme, was cut up into 1,342 rectangles of 4,000 acres each by locating on the ground 1,920 corners; 1,299 dressed stones were embedded on the main and 2,000-acre corners in the Agricultural or "*Included* Thal," and 430 iron rails were embedded on main corners in the High or "*Excluded* Thal".

Sub-division into 100-acre rectangles was carried out over the northern part of the tract, comprising an area of 3644·4 square miles, and embracing parts of Miānwāli, Shāhpur, and Jhang districts; 23,324 rectangles of 100 acres each were laid out and their corners were marked by stones. Nearly 73 per cent. of the work was tested by the superior revenue staff and the survey officers. The party has now to deal with the sub-division into 100-acre rectangles in southern area of the tract already divided into 719 rectangles of 4,000 acres each. This will be done next field season.

Traversing amounting to 279·9 linear miles was also carried out by the party in the strip of thickly wooded country, along the western edge of the "Thal" in Muzaffargarh district, in which triangulation was impracticable. In this tract also, approximate area 405 square miles, the corners of 4,000-acre and 2,000-acre have been located.

The country under rectangulation lies between the Indus river on the west and the Jhelum and Chenāb rivers on the east and is locally known as "Thal" (uplands). The tract is a vast rolling desert of sand studded with

hillocks, sparsely populated and almost waterless. The village wells are generally brackish. The "Thal", with the exception of the north-eastern portion which is more cultivated, is covered by low tree growth. The natural difficulties of the ground make the work arduous and slow.

In recess the party was employed on completion of the computations of triangulation and traverse and other records of the Sind-Sāgar rectangular survey, and also on half-inch fair-mapping, from the middle of July to the end of September 1919.

Punjab Riverain Survey Party—As in previous years, this party was employed on local surveys in the Punjab. The details of the work done are given on pages 18 and 19.

69. Southern Circle.—The survey of cantonments and military stations was continued by No. 20 Party. The details of the work are given on page 20.

The Royal Artillery Practice Camps of Kāpra, in the Hyderābād State and of Rājankunti in the Mysore State, which were surveyed on the scale of 3 inches = 1 mile by Nos. 6 and 8 Parties respectively the previous year, were fair-mapped by No. 5 Party and submitted for publication.

The special survey on the scale of 1½ inches=1 mile of reserved forests in the Hyderābād State was continued by No. 6 Party, and an area of 237 square miles was surveyed. The cost of the work is being borne by the Nizām's Government.

70. Head Quarter Offices.—Details of all extra-departmental publications during the year for the Army, for Local Governments and for other Government offices are given in Table A of the Photo.-Litho. Office report on page 34, in the "Issues" Table and in Table IV of the Map Repord and Issue Office report on pages 28 and 29.

In addition to the special maps for other departments which are mentioned in para. 54 (*g*) on page 27, these extra-departmental publications include Royal Artillery Practice Camp maps and various operation and manœuvre maps for the Army; maps to illustrate the Hydro-Electric Survey Report, the Journals of the United Service Institution, various reports of Government officials, &c.; large numbers of special diagrams for the Railway Board and of forms for Government Promissory Notes; the reprint of a Persian Grammar text book; and the usual large numbers of Weather charts for the Meteorological Department and of photogravure and half-tone illustrations for the Archæological and other departments.

The work entailed by the preparation of originals for some of these special maps, in addition to their publication, is mentioned in the reports of No. 1 Drawing Office and of the Engraving Office on pages 30 to 33.

71. Mathematical Instrument Office.—The manufacture of heliographs, prismatic compasses Mark VIII, scales, protractors, &c., was continued throughout the year. Practically all repair and manufacture work of a civil nature was put aside. Large numbers of metre staves and chains were manufactured to meet Mesopotamia's demands. Several engraving machines were manufactured to facilitate work on scales and protractors, &c.

Instruments were supplied by this office to many Government offices, Imperial and Provincial.

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2. Publication of modern one-inch series.
3. ,, modern half-inch series for India.
4. ,, ,, quarter-inch ,, ,,
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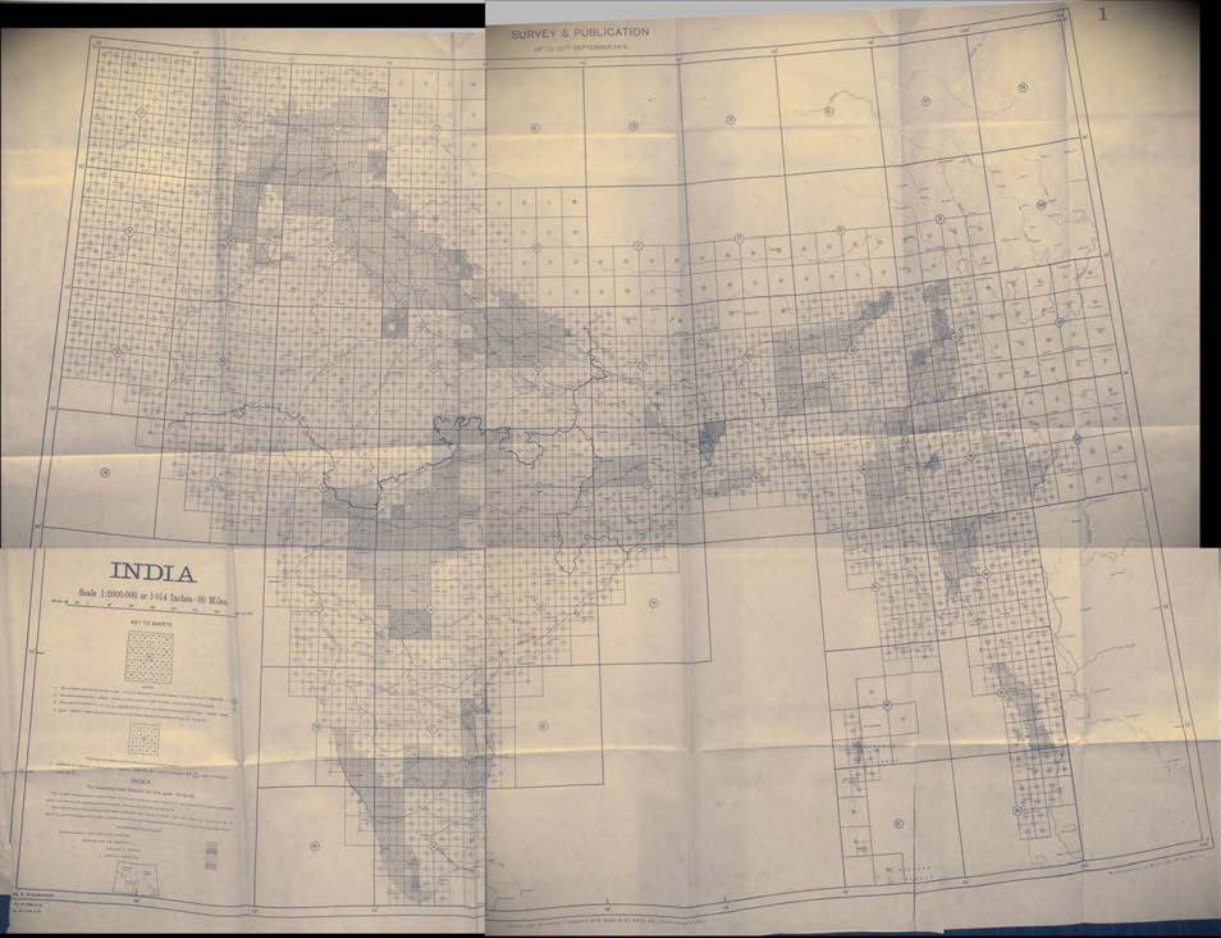
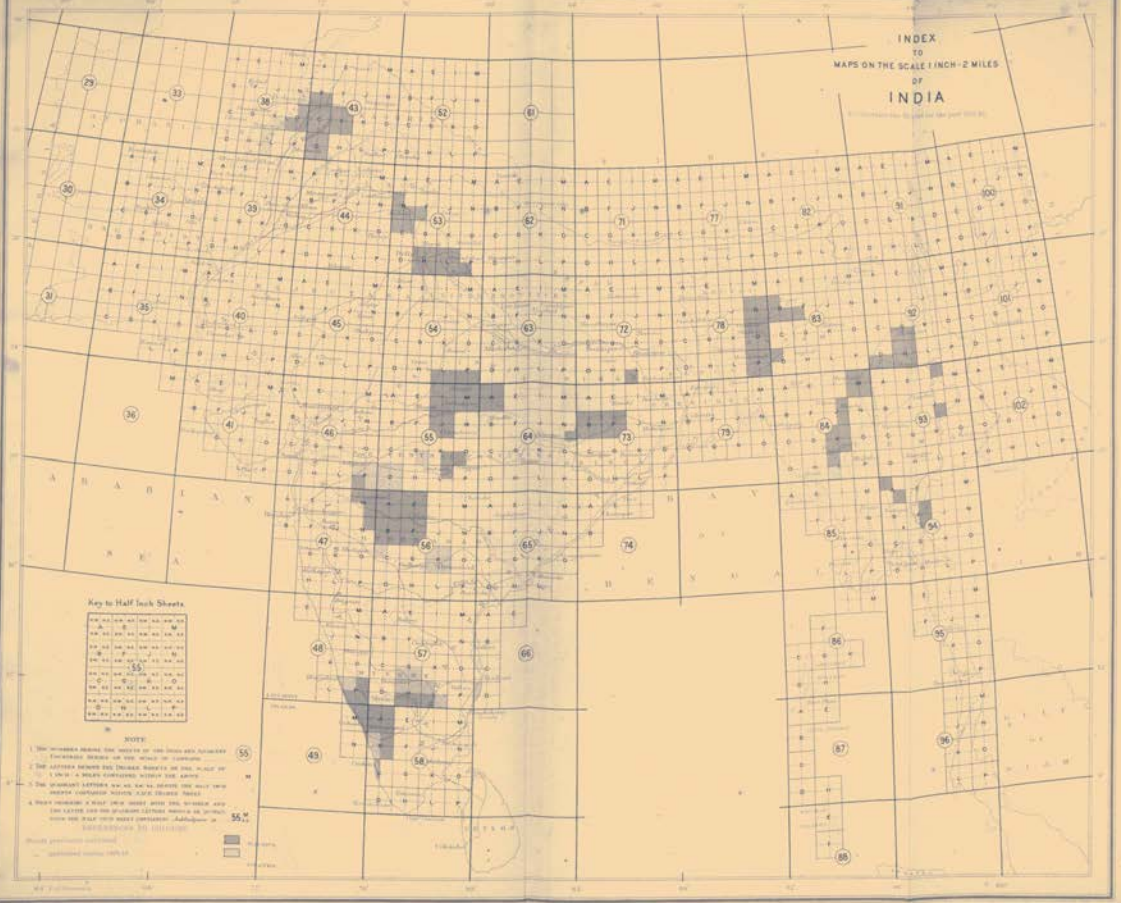
6. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
7. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
8. Progress of the Great Trigonometrical Survey.

UP TO 30th SEPTEMBER, 1919
INDIA
Scale 1:5000,000, or 1·014 Inches - 80 Miles.
KEY TO SHEETS


SURVEY & PUBLICATION
INDIA
Scale 1:6000000 or 1·014 Inches=96 Miles.

SURVEY & PUBLICATION

INDIA
Scale 1:5000,000 or 1·014 Inches=80 Miles.
KEY TO SHEETS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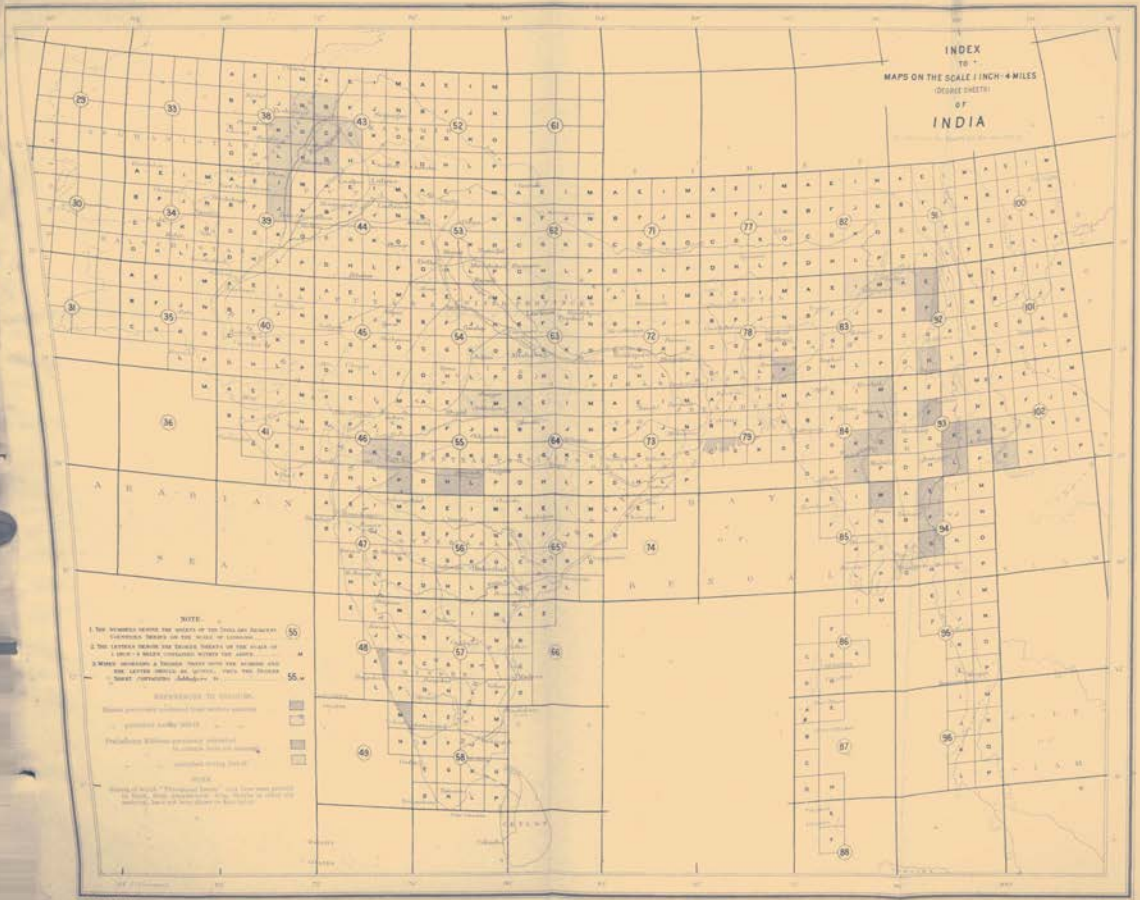
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3. WHERE SEPARATED BY A DEGREE SHEET BOTH THE NUMBERS AND
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DEGREE SHEET SERIES

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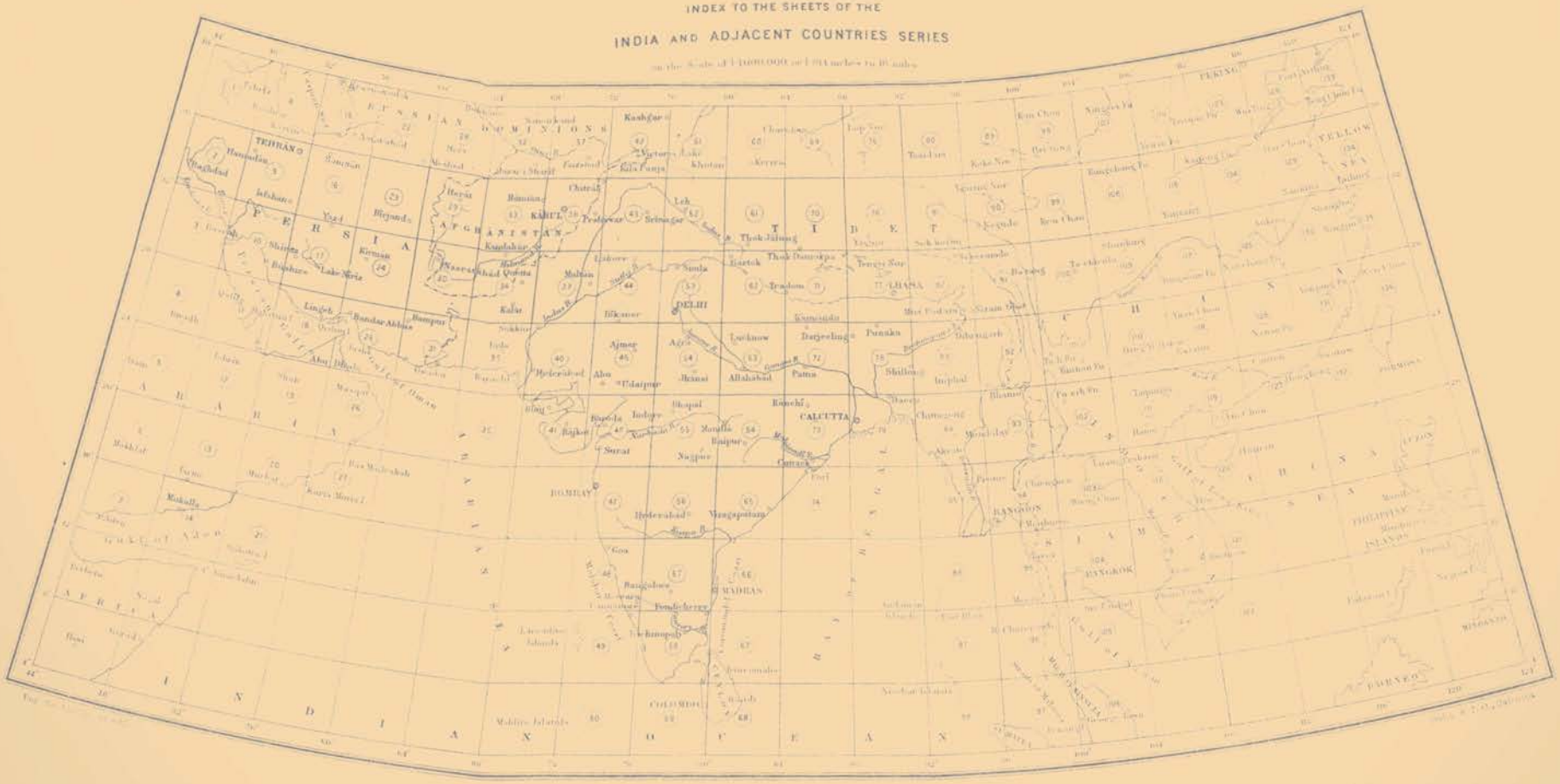
on the Scale of 1 : 1,000,000 or 1 Inch to 15 Miles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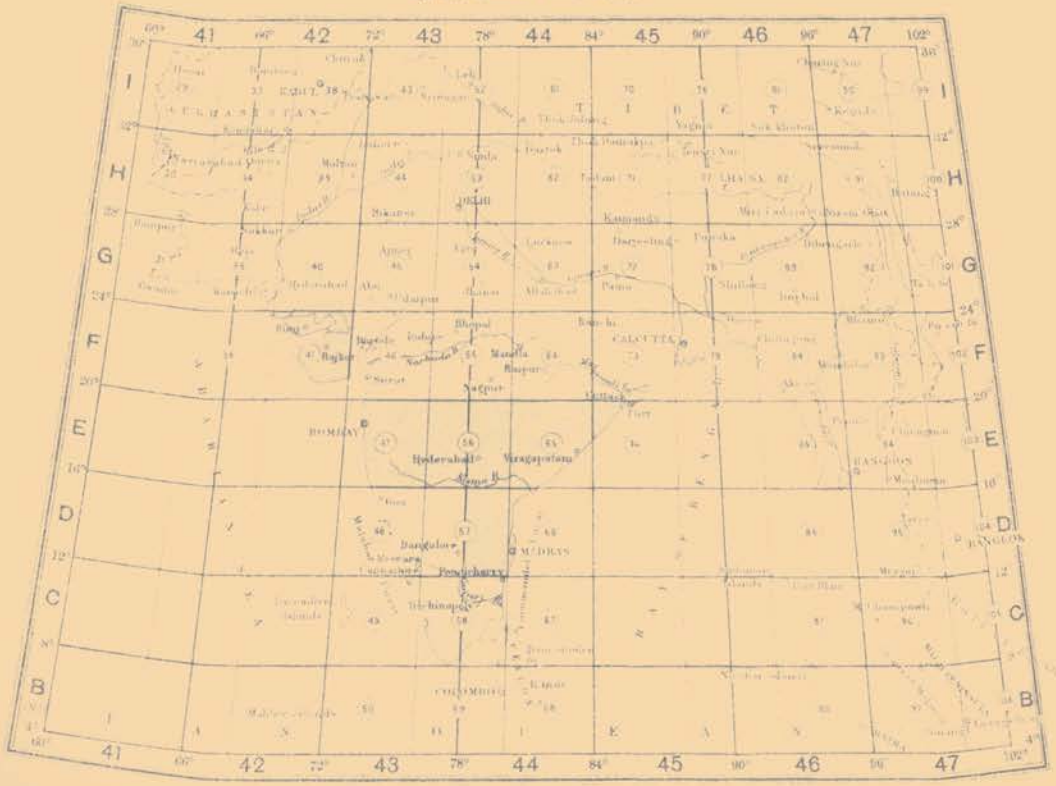

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The figures in circles are the numbers of the sheets of the [illegible] Edition on the Scale of 1:2,000,000.

INTERNATIONAL SERIES

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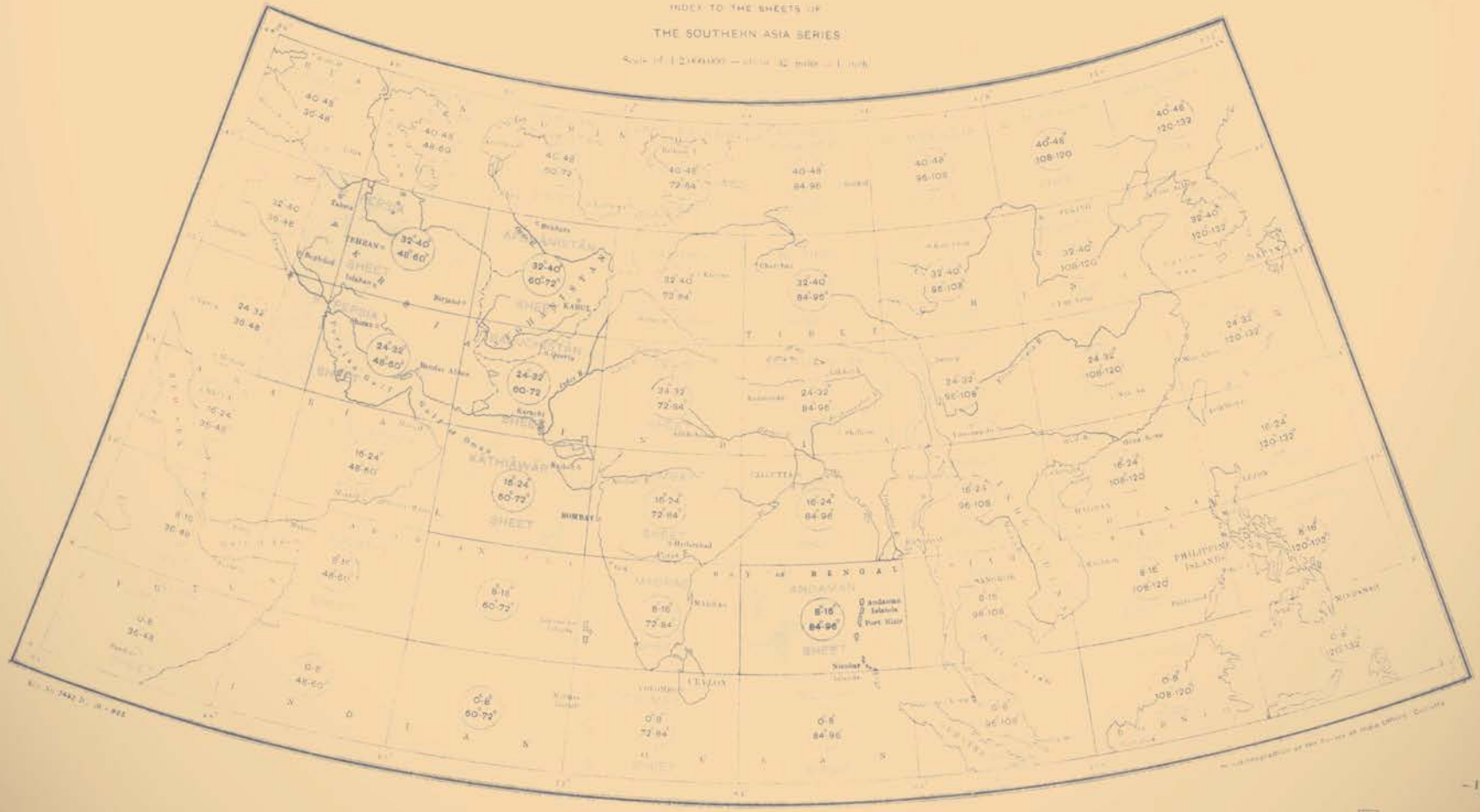
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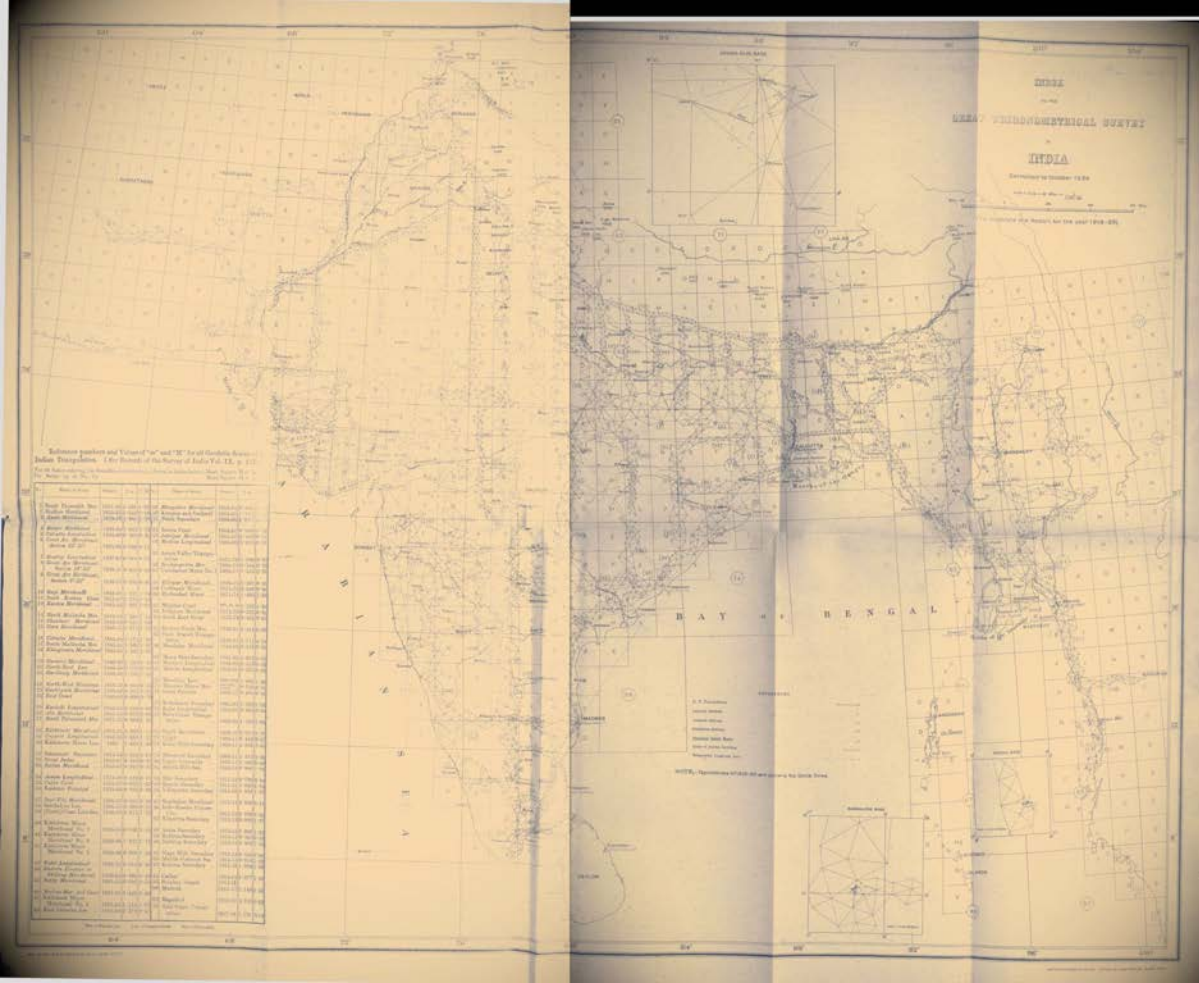
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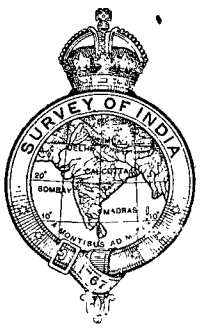

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PREPARED UNDER THE DIRECTION OF

COLONEL C. H. D. RYDER, C.I.E., D.S.O., R.E.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA.

CALCUTTA,

1921.

PRINTED AT THE
PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, SURVEY OF INDIA,
14, WOOD STREET,
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NOTICE.

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1. TOPOGRAPHICAL MAPS are published on the scales of 4 MILES TO 1 INCH, 2 MILES TO 1 INCH AND 1 MILE TO 1 INCH :—

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(*b*) INDIA AND ADJACENT COUNTRIES, scale 1:1,000,000 or nearly 16 miles to 1 inch, in LAYERED and POLITICAL editions, and from old surveys as PROVISIONAL ISSUES, size 24 INCHES × 19 INCHES, price Rs. 1-8-0 per copy.

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8. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1919—20.

From 1st October 1919
To 30th September 1920.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shown in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XV of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 30,464* square miles; and that this brings the total progress since 1905 to 540,774 square miles, leaving 1,280,826 square miles still to be done.

3. The first Index map, at the end of the report, shows the progress of this topographical programme both in survey and in publication in the three circles, while the remaining seven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the survey of India is based.

4. Table IV on page 28 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

---

*Excluding 38 square miles large scale survey on the scale of 12", 16" and 24"=1 mile.

6. The following events are notified:—

(*a*) Owing to the shortage of officers the field work was again curtailed, but to a lesser extent than in the previous year.

(*b*) The personnel of the Mesopotamian Survey Party was placed on foreign service under the Mesopotamian administration from 1st January 1920.

(*c*) The Birjand and South-West Persia Survey Detachments, which had been employed in East and South-West Persia, returned to India on completion of their work in September and May 1920 respectively and were disbanded.

A party designated the Waziristān Survey Party was formed under a Class I officer for service on the North-West Frontier. This party returned to Mussoorie in June 1920.

The Military Authorities expressed great satisfaction at the work carried out by these Survey units.

(*d*) Major H. T. Morshead, D.S.O., R.E., and Mr. Laltan Khan, I.D.S.M., accompanied Dr. A. M. Kellas on his attempt to climb Mount Kāmet (25,445 feet). The party had not returned by the end of the year but it is known that the attempt failed at 23,500 feet.

(*e*) A Training School was formed in Maymyo for instruction of pupils recruited for the parties in Burma.

(*f*) The increase in the demand for special and large scale surveys has continued.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1920 and of the two previous years is shown below:—

	1917-18.	1918-19.	1919-20.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	40,33,295	38,38,091	**44,53,872***	* These figures are not final.
Deduct receipts and credits	17,58,796	18,83,964	**20,30,389***	
Net actual cost ..	22,74,499	19,54,127	**24,23,483***	

8. Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., administered the department till 20th April 1920 when he proceeded on leave to England. Lieutenant-Colonel W. M. Coldstream, R.E., officiated for him for the rest of the year.

9. The names of the following officers who served in His Majesty's Forces and who died in the Great War have been placed on record by the Governor-General in Council:—

Bt.-Major (Temporary Lt.-Col.) Archibald Alderman Chase, D.S.O., R.E.
Captain Rowland Latimer Almond, R.E.
,, Edward Carlton Baker, R.E.
,, Edward Bellasis Cardew, R.E.
,, John Archibald Field, R.E.
,, Henry Marshall McKay, R.E.
,, George Frederick Thomas Oakes, R.E.
Lieutenant Vivian Donald Berry Collins.
,, Walter Percy Hales, I.A.R.O.
Jemadar Ram Charan, Surveyor.

10. By the reorganisation of the Imperial and Provincial Services of the department, Imperial and certain selected Provincial Officers are now styled Class I officers, the remainder of the Provincial Service being styled Class II. Practically the whole of the various establishments of the department have been reorganised during the year to meet the increased cost of living.

11. Of Class I officers:—Colonel T. F. B. Renny-Tailyour, C.B., C.S.I., R.E., and Lieutenant-Colonel R. T. Crichton, C.I.E., I.A., retired and Major M. N. MacLeod, D.S.O., M.C., R.E., and Major K. W. Pye, D.S.O., R.E., reverted to the Home Establishment.

The following officers were appointed during the year:—

Bt.-Major E. O. Wheeler, M.C., R.E., Captains E. A. Glennie, D.S.O., R.E., H. A. Joly deLotbinière, M.C., R.E., O. Slater, M.C., R.E., and G. Lennox, I.A.

The number of officers on deputation to military duty at the end of the year is 2.

Captain H. G. Salmond whose services were placed at the disposal of this department to assist in experiments in producing maps from aeroplane photographs reverted to the Eastern Bengal Railway.

Of Class II officers:—Mr. H. A. Charrier retired, Messrs R. B. Gildea, F. E. R. Calvert, R. M. Wyatt and A. J. Moore resigned. Mr. W. Newland was transferred to the Government of Bombay. Mr. B. M. Berrill and Mr. P. Simpson were placed on deputation with the Bombay, and Bihār and Orissa Governments, respectively.

The number of officers on deputation to military duty at the end of the year is 2.

In the Upper Subordinate Service, Messrs Hari Ramchandra Jogalekar, and Eknath Battu retired.

The total strength of the department at the close of the Survey year was 55 † Class I officers, 98 ‡ Class II officers and 57 Upper Subordinates, besides specialists, clerks, lower subordinates and menials.

12. The following honours were conferred during the year:—

Officers of the Order of the British Empire.—	Captain (Tempy. Lieut.-Colonel) R. S. Wauchope, I.A.
Members of the Order of the British Empire.—	Mr. D. K. Rennick, Extra Assistant Superintendent.
	Assistant Commissary and Hony. Lieutenant R. Graham.
Mentioned in despatches.—	Major H. McC. Cowie, R.E., (second time).
	Brevet-Lieut.-Colonel C. P. Gunter, O.B.E., R.E., (second time).
	Brevet-Lieut.-Colonel C. M. Browne, C.M.G., D.S.O., R.E., (fifth time).
	Captain (Tempy. Lieut.-Colonel) R. S. Wauchope, I.A.
	Surveyor Khitab Gul.
Brought to the notice of the Secretary of State for war services.—	Lieutenant R. B. Gildea, I.A.R.O., (resigned).
	Mr. F. H. Grant, Extra Assistant Superintendent.
	Surveyor Mansab Khan.
Doctor of Science (Cambridge University.)—	Mr. J. deGraaff Hunter, M.A.
Title of Rai Sahib.—	Mr. Jagdamba Prasad, Extra Assistant Superintendent.
Title of Ahmudan gaung Tazeik ya Min.—	Maung Pe, Sub-Assistant Superintendent.

13. The following table shows the distribution of officers during the year. The names of officers on deputation to Local Governments or military duty or absent on military duty followed by leave throughout the year are omitted; the names of officers, other than officers in charge, on leave, military duty, or foreign service, during the greater part of the year are also omitted.

† Including 2 officers on temporary military duty.

‡ Including 2 officers on temporary military duty, but excluding officers re-employed and on deputation to Local Governments.

TABLE I—DISPOSITION OF OFFICERS, 1919-20.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
SURVEYOR GENERAL OF INDIA—	Colonel C. H.D. Ryder, C.I.E., D.S.O., R.E. (on leave from 20th April 1920). Lieut.-Colonel W. M. Coldstream, R.E., Officiating from 20th April 1920.			
Surveyor General's Office.	Major H. J. Couchman, D.S.O., M.C., R.E. Captain W. E. Perry, M.C., R.E.			
*Mesopotamian Survey Party.	Bt.-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A. Major E. T. Rich, C.I.E., R.E. ,, F. F. Hunter, D.S.O., I.A. Dr. J. deGraaff Hunter, Sc. D., M.A.	Mr. V. W. Morton ,, C. West ,, B. C. Newland ,, E. C. O'Sullivan, D.C.M. ,, F. B. Kitchen ,, A. F. Murphy	Mr. Hayat Muhammad Khan, K.S. ,, Nanak Chand Puri, B.A., R.S. ,, Hamid Gul, K.S., C.H. ,, Ananda Prasad Ghosh ,, Abdul Latif Khan	16 Surveyors, &c.
SUPERINTENDENT, MAP PUBLICATION—	Lieut.-Colonel H. H. Turner, R.E., up to 3rd February 1920. ,, G. A. Beazeley, D.S.O., R.E., from 4th February 1920.			
	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud (re-employed).		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Bt.-Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Major H. J. Couchman, D.S.O., M.C., R.E. ,, O. H. B. Trenchard, R.E. ,, C. M. Thompson, I.A.	Mr. P. Williams ,, Jagdamba Prasad, R.S. ,, Pramadaranjan Ray, R.S. ,, Abinash Chunder Bose ,, C. West ,, Asmat-ullah Khan, R.D. ,, A. B. Hunter ,, Priya Nath Sur ,, L. B. Fitz-Gibbon ,, H. H. P. Butterfield ,, Jiya Lal Sahgal		
Photo.-Litho. Office, Calcutta.	Major A. R. Gwyn, I.A.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier, C.B.E. (on combined leave). ,, S. Woodhouse (Offg.).			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).		Mr. P. Simpson Mr. C. West.		
No. 6 (Simla) Drawing Office.	Major L. G. Crosthwait, I.A. ,, C. J. Arbery, M.B.E.	Mr. R. E. M. Saubolle ,, A. J. A. Drake, D.C.M.		4 European Draftsmen. 4 Printers. 2 Clerks. 15 Indian Draftsmen. 2 Pupil Draftsmen.
SUPERINTENDENT, NORTHERN CIRCLE	Lieut.-Colonel R. T. Crichton, C.I.E., I.A., up to 7th March 1920. Lieut.-Colonel H. L. Crosthwait, R.E., from 8th March 1920.			
	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.	Major L. G. Crosthwait, I.A. Mr. J. A. Freeman	Mr. E. B. West ,, D. K. Rennick, M.B.E. ,, L. Williams ,, A. A. Graham ,, J. A. Calvert ,, H. G. Shaw (re-employed).	Mr. Imam Din ,, Jit Singh Rawat	41 Surveyors, &c.
No. 1 Party, *Punjab and United Provinces.*	Bt.-Lieut.-Colonel A. A. McHarg, D.S.O., R.E. Captain H. E. Roome, M.C., R.E. Bt.-Major K. Mason, M.C., R.E. Major H. T. Morshead, D.S.O., R.E.	Mr. G. J. S. Rae ,, P. A. T. Kenny ,, A. M. Talati ,, R. C. Hanson ,, F. J. Grice ,, J. A. Calvert	Mr. Jamna Prasad, B.S. ,, Muhammad Husain Khan ,, Jagdeesh Prasad Vastav ,, Muhammad Khan	49 Surveyors, &c.
No. 2 Party, *Punjab, Rājputāna and United Provinces.*	Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E.	Mr. H. P. D. Morton ,, Duni Chand Puri	Mr. Muhammad Husain ,, Lakshmi Dutt Joshi ,, Ghulam Hasan ,, Daulat Ram Vohra ,, Laltan Khan, I.D.S.M.	46 Surveyors, &c.
No. 3 Party, *United Provinces.*	Bt.-Major C. G. Lewis, R.E. Mr. H. H. B. Hanby	Mr. B. M. Berrill ,, J. H. Johnson ,, G. E. R. Cooper ,, Moqimuddin Ahmad	Mr. Paras Ram ,, Hamid Gul, K.S. ,, Amir Abdul Salam Matlub	33 Surveyors, &c.
No. 4 Party, *United Provinces.*	Lieut.-Colonel E. A. Tandy, R.E. ,, R. T. Crichton, C.I.E., I.A. Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E. Major L. G. Crosthwait, I.A. ,, H. T. Morshead, D.S.O., R.E. Lieut.-Colonel H. L. Crosthwait, R.E. Captain L. H. Jackson, I.A.	Mr. Abdul Karim, B.A.	Mr. Nabidad Khan	1 Clerk.
Sind-Sāgar Party, *Punjab.*		Mr. Dhani Ram Verma ,, J. C. Lears ,, Abdul Karim, B.A.	Mr. Chuni Lal Kapur ,, Nabidad Khan	28 Surveyors, &c. 105 Local Revenue staff.
No. 22 (Riverain) Party, *Punjab.*		Mr. Maya Das Puri, B.S.	Mr. Ram Narayan Hastir ,, Vidya Dhar Chopra	69 Surveyors, &c. 1 Nāib Tahsildār.
Waziristān Survey Party, *Waziristan.*	Lieut.-Colonel H. L. Crosthwait, R.E. Major H. T. Morshead, D.S.O., R.E.	Mr. P. A. T. Kenny ,, F. J. Grice ,, J. A. Calvert	Mr. Muhammad Husain Khan ,, Shib Lal ,, Sadik Ali	9 Surveyors, &c.
Birjand Survey Detachment, *North-East Persia.*		Mr. G. A. Norman	Mr. Afraz Gul	3 Surveyors, &c.
Simla Survey Detachment, *Simla.*		Mr. W. H. Strong, M.B.E.		10 Surveyors, &c.

* The personnel of the party was transferred to foreign service under the Mesopotamian administration from 1st January 1920.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1919-20.

SUPERINTENDENT, SOUTHERN CIRCLE { Lieut.-Colonel W. M. Coldstream, R.E., up to 19th October 1919. Major L. C. Thuillier, I.A., from 20th October to 10th November 1919. Lieut.-Colonel E. A. Tandy, R.E., from 11th November 1919 to 20th January 1920. Brevet-Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 21st January 1920.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.	Mr. J. H. Nichol	Mr. S. F. Norman	Mr. B. V. Narayana Rao	39 Draftsmen, &c.
No. 5 Party, *Central Provinces.*	Major L. C. Thuillier, I.A.	Mr. S. F. Norman ,, H. B. Simons ,, F. C. Pilcher ,, F. W. Smith	Mr. P. S. Venguswami ,, Damodar Khadilkar ,, Pulin Behari Roy	36 Surveyors, &c.
No. 6 Party, *Bombay, Madras, and Hyderābād.*	Mr. J. O'B. Donaghey	Mr. E. A. Meyer ,, Munshi Lal, B.A. ,, N. S. Hariharа Iyer	Mr. K. G. Mandanna ,, Masud Khan ,, E. N. Natesan	32 Surveyors, &c.
No. 7 Party, *Madras.*	Major J. D. Campbell, D.S.O., R.E.	Mr. H. B. Simons ,, S. F. Norman ,, C. E. C. French ,, J. H. S. Wilson ,, Haji Abdul Rahim, K.B. ,, F. H. Grant	Mr. Eknath Battu ,, K. Narayanaswami Chetti ,, Damodar Khadilkar	16 Surveyors, &c.
No. 8 Party, *Madras.*	Mr. W. M. Gorman	Mr. C. E. C. French ,, S. F. Norman ,, M. Mahadeva Mudaliar, M.A. ,, B. T. Wyatt ,, M. S. Ganesa Aiyar ,, J. C. St. C. Pollett	Mr. H. Narasimhamurti Rao ,, Shaikh Muhammad Salik	12 Surveyors, &c.
No. 20 Party, *Cantonment and Military District Lands in the 9th Division.*	Mr. B. R. Hughes	Mr. C. E. C. French ,, J. H. S. Wilson ,, O. D. Jackson	Mr. Dharma ,, Jitendra Mohan Mukerji	26 Surveyors, &c.
Training Section		Mr. S. S. McA'F. Fielding		22 Surveyors, and Pupils.

SUPERINTENDENT, EASTERN CIRCLE { Lieut.-Colonel C. L. Robertson, C.M.G., R.E., up to 24th October 1919. Lieut.-Colonel W. M. Coldstream, R.E., from 25th October 1919 to 19th April 1920. Major E. T. Rich, C.I.E., R.E., from 20th April 1920.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.	Mr. M. C. Petters	Mr. Pramadaranjan Ray, R.S. ,, E. Claudius ,, C. S. McInnes	Mr. Jagdeesh Prasad Vastav ,, Dalbir Rai	27 Surveyors, &c.
No. 9 Party, *Bengal.*	Bt.-Lieut.-Colonel R. H. Philimore, D.S.O., R.E.	Mr. E. J. Biggie ,, Amar Krishna Mitra	Mr. Amulya Charan Ghosh ,, Gopal Lal Mitra	23 Surveyors, &c.
No. 10 Party, *Upper Burma.*	Mr. M. C. Petters	Mr. W. G. Jarbo ,, H. H. Creed ,, Dhirendra Nath Banerji, L.C.E.	Mr. Hayat Muhammad, K.S. ,, Dhirendra Nath Saha ,, Ram Prasad, R.S. Maung Pe, A.T.M.	17 Surveyors, &c.
No. 11 Party, *Lower Burma.*	Mr. J. O. Groiff	Mr. O. J. H. Hart ,, E. M. Kenny ,, H. T. Hughes ,, F. C. Saint	Mr. Pratul Chandra Sen Gupta, B. Sc. ,, Dalbir Rai	26 Surveyors, &c.
No. 12 Party, *Assam.*	Major F. B. Scott, I.A.	Mr. E. G. Hardinge ,, E. M. Kenny ,, Prafulla Chandra Mitra, B.A.	Mr. Girija Sonker Bagchi	30 Surveyors, &c.
No. 21 (Burma Forest) Party, *Upper Burma.*	Mr. H. W. Biggie	Mr. W. G. Jarbo ,, C. O. Picard ,, C. B. Sexton	Mr. Bhamba Ram	9 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1919-20.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY { Colonel Sir Gerald P. Lenox-Conyngham, Kt., R.E., F.R.S., up to 15th May 1920. Major R. H. Thomas, D.S.O., R.E., from 16th May 1920.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	Major H. T. Morshead, D.S.O., R.E. Captain L. H. Jackson, I.A. Bt.-Major E. O. Wheeler, M.C., R.E. Captain E. A. Glennie, D.S.O., R.E. ,, O. Slater, M.C., R.E. ,, G. Lennox, I.A. *(Attached)* ,, H. G. Salmond (on deputation from Eastern Bengal Railway).	Mr. A. Ewing (re-employed) *(Probationers).* Mr. Prafulla Kumar Ghosh, B. Sc. ,, Bhupendra Nath Saha, M. Sc. ,, H. M. Critchell ,, Mahammad Najamuddin, B.A. ,, T. O. Threlfall	Mr. Lalfan Khan, L.D.S.M.	
Computing Office.	Dr. J. deGraaff Hunter, Sc. D., M.A. Major C. M. Thompson, I.A.	Mr. Hanuman Prasad	Mr. Sarat Kumar Mukerji	43 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major F. J. M. King, R.E.	Mr. C. C. Byrne ,, H. P. D. Morton ,, Rama Prasad Ray, B.A. Major C. H. Tresham Mr. J. McCraken, M.B.E. ,, T. F. Kitchen ,, V. P. Wainright ,, F. C. Saint	Mr. Lal Singh, R.B., (re-employed). ,, Ram Singh, R.S. ,, Jugal Behari Lal ,, Baldeo Behari Lal ,, Sadik Ali	189 Draftsmen, &c.
No. 13 Party, *(Astronomical).*	Dr. J. deGraaff Hunter, Sc.D., M.A. Bt.-Major C. G. Lewis, R.E. Captain G. Lennox, I.A.			1 Computer.
No. 14 Party, *(Pendulum).*	Lieut.-Colonel G. A. Beazeley, D.S.O., R.E. Bt.-Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Major E. T. Rich, C.I.E., R.E. ,, R. H. Thomas, D.S.O., R.E. ,, C. M. Thompson, I.A. Captain E. A. Glennie, D.S.O., R.E.			1 Clerk.
No. 15 Party, *(Triangulation).*	Major R. H. Thomas, D.S.O., R.E. Captain O. Slater, M.C., R.E.	Lieut. C. S. McInnes		5 Computers, &c.
No. 16 Party, *(Tidal).*	Mr. O. C. Ollenbach	Mr. Syed Zille Hasnain, K.S. ,, D. H. Luxa		20 Computers, &c.
No. 17 Party, *(Levelling).*	Bt.-Major K. Mason, M.C., R.E.	Mr. H. G. Shaw (Re-employed). ,, O. N. Pushong ,, K. S. Gopalachari, B.A. ,, Narendra Nath Chuckerbutty, L.C.E.	Mr. Karuna Kumar Das, B.A. ,, Satish Chandra Mukerjee	12 Computers, &c.
No. 18 Party, *(Magnetic).*		Mr. E. C. J. Bond, V.D. ,, Nikunjo Ronjon Mazumdar ,, Raj Bahadur Mathur, B.A.	Mr. Bidhu Bhusan Shome	2 Magnetic Observers. 12 Computers, &c.
No. 19 Party, *(Base Line).*	Major H. J. Couchman, D.S.O., M.C., R.E. ,, O. H. B. Trenchard, R.E. ,, C. M. Thompson, I.A.			1 Clerk.

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

14. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905 and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shown in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 580,400 square miles are likely to be surveyed on the half-inch or smaller scales.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
1917-18 ...	ditto ...	4,202	12,181	8,396	24,779
1918-19 ...	ditto	509	7,263	6,176	13,948
1919-20	ditto ...	**9,145***	**11,891**	**9,428**	**30,464**
Total areas completed to date		**221,455**	**174,321**	**144,998**	**540,774**
Approximate areas for the whole topographical programme.		**750,000**	**542,800**	**528,800**	**1,821,600**
Approximate areas remaining for survey.		**528,545**	**368,479**	**383,802**	**1,280,826**

* Excluding 38 square miles large scale survey on the scales of 12", 16" and 24"=1 mile.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1919-20.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
NORTHERN CIRCLE.						
No. 1 Party—*Punjab and United Provinces.*						
Wooded hills	½-inch Revision Survey	252	5,218	1,31,704	25·2	
Ditto	1-inch Original Survey	87				
Ditto	1-inch Revision Survey	4,841				
	Large-Scale Survey	38				
No. 2 Party—*Punjab, Rājputāna and United Provinces.*						
Mountainous, covered with heavy low jungle and thick grass.	½-inch Original Survey	264	2,638	65,417 (a)	24·8	(a) Excludes Rs. 8,645 debitable to Rājputāna, Rs. 5,290 cost of ½-inch mapping and Rs. 53,682 cost of training pupils and soldier surveyors.
Cultivated plains, open with occasional isolated low rocky hills.	1-inch Original Survey	418				
Cultivated plains, open	1-inch Resurvey	1,426				
Ditto ditto	2-inch Resurvey	265				
Ditto ditto	3½-inch Experimental Aeroplane Survey.	265				
No. 3 Party—*United Provinces.*						
Wooded hills	2-inch Original Survey	1,237	1,327	1,05,331 (b)	79·4	(b) Excludes Rs. 8,855 cost of Simla Survey.
	1-inch Resurvey	90				
TOTALS, NORTHERN CIRCLE:—		9,183 sq. m.		Rs. 3,02,452	Cost-rate 32·9	
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**SOUTHERN CIRCLE.**
No. 5 Party—*Central Provinces.*						
Well-wooded hills and cultivated plains.	1-inch Original Survey	2,667	3,027	99,715	32·9	
	1-inch Revision Survey	360				
No. 6 Party—*Bombay, Madras and Hyderābād.*						
Undulating and cultivated	½-inch Original Survey	3,383	4,191	94,386	22·5	
	½-inch Supplementary Survey	108				
	1-inch Original Survey	298				
	3-inch Original Survey	70				
	3-inch Supplementary Survey	50				
Wooded hills	1½-inch Original Survey	282				
No. 7 Party—*Bangalore.*		...	...	...	...	Did not take the field.
No. 8 Party—*Madras.*						
Undulating and cultivated plains with a coastal belt of palmyra palms.	1-inch Supplementary Survey	4,523	4,673	1,21,487	26·0	
	1-inch Original Survey	147				
Small wooded patches of babul and other trees.	2-inch Forest Survey	3				
TOTALS, SOUTHERN CIRCLE:—		11,891 sq. m.		Rs. 3,15,588	Cost-rate 26·5	

Table III.—(Concluded).—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1919-20.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
EASTERN CIRCLE.						
No. 9 Party—*Bengal.*						
Flat and cultivated plains	1-inch Original Survey	2,299	2,344	80,937 (a)	34·5	(a) Excludes a sum of Rs. 1,439, on account of half-inch mapping, Rs. 7,008, for twelve-inch mapping, Rs. 169, for twelve-inch computation, Rs. 117, for twelve-inch survey and Rs. 7,127, for instruction of pupils.
Ditto. ditto.	1½-inch Revision Survey	45				
No. 10 Party—*Upper Burma.*						
High mountains with densely wooded valleys.	½-inch Original Survey	2,516	3,239	1,46,797	45·3	
Densely wooded hills	1-inch Original Survey	723				
No. 11 Party—*Lower Burma and Northern Shan States.*						
Intricate hills and low ground covered with mangrove swamp and densely wooded.	1-inch Original Survey	1,631	1,754	2,00,681 (b)	114·4	(b) Includes cost of Maymyo Drawing Office.
High hills sparsely wooded and rocky.	1-inch Resurvey	20				
Low hills with open undulating ground cultivated and scrub jungle.	3-inch Original Survey	103				
No. 12 Party—*Assam.*						
Hills, consisting partly of a plateau cut up by ravines with stretches of grass lands and foot hills densely wooded.	½-inch Original Survey	1,099	1,967	1,24,251	63·2	
Plains, partly under cultivation and partly densely wooded.	1-inch Original Survey	578				
Plains and hills densely wooded	2-inch Original Survey	290				
No. 21 (Burma Forest) Party—*Upper Burma.*						
Wooded hills	2-inch Original Survey	88	124	94,877	765·1	
Ditto.	4-inch Original Survey	36				
TOTALS, EASTERN CIRCLE:—		9,428 sq. m.		Rs. 6,47,543	Cost-rate	68·7
GRAND TOTALS:—		30,502 sq. m.		Rs. 12,65,583	Cost-rate	41·4

NORTHERN CIRCLE (*vide* Index map No. 1).

15. No. 1 Party.—5,180 square miles of topographical survey were completed during the year under report chiefly 1-inch and ½-inch revision survey in the Simla Hill States, Sirmūr, Mandi and Kāngra district.

The party also completed the large scale surveys of the cities of Lahore and Ferozepore which had been commenced during the previous season (vide page 18). In addition a large scale survey of Mussoorie City was carried out at the cost of the City Board (vide page 42).

16. No. 2 Party.—This party surveyed an area of 264 square miles on the ½-inch scale in Alwar State, 441 square miles on the scale of 1 inch = 1 mile in the Gurgaon district of the Punjab, 962 square miles on the scale of 1 inch = 1 mile in the Muttra and Aligarh districts of the United Provinces, 412 square miles on the scale of 1 inch = 1 mile in the Bharatpur State and 29 square miles on the scale of 1 inch = 1 mile in the Alwar State, both of the Rājputāna Agency, making a total of 1,844 square miles on the 1-inch scale, and 265 square miles on the scale of 2 inches = 1 mile (for instructional purposes) in the Muttra and Agra districts of the United Provinces. Traversing was also carried out in the Bharatpur State.

The country surveyed on the scale of ½ inch 1 mile in Alwar State was hilly and difficult of access, being mostly covered with heavy low jungle and thick grass, while that surveyed on the scales of 1 inch and 2 inches — 1 mile, and the area traversed, consisted of cultivated plains open and easy except for a few isolated low rocky hills in Bharatpur State.

The party also combined with No. 13 Party (vide page 20) in an experimental aeroplane survey on a scale of approximately 3½ inches = 1 mile of an area comprising 125 square miles in the Bharatpur State of the Rājputāna Agency, 398 square miles in the Agra district and 7 square miles in the Muttra district of the United Provinces, the whole consisting of cultivated plains except for the few rocky out-crops in the neighbourhood of Fatehpur Sikri.

Half this area was also surveyed on the scale of 2 inches = 1 mile.

The large scale survey of Mount Abu and vicinity commenced in July 1919 on the scale of 24 inches = 1 mile comprising a total area of 5,076 acres was completed (*vide* page 42).

17. No. 3 Party.—This party surveyed an area of 1,327 square miles mainly on the scale of 2 inches = 1 mile in the Garhwāl, Almorā and Nainī Tāl districts of the United Provinces, and triangulated an area of 1,250 square miles in Garhwāl and Almorā districts and in Tehrī-Garhwāl State.

The survey of Kumaon hills is being executed chiefly in the interests of the Forest Department, (*vide* page 16) and the maps for that department, as well as the public edition, will be published on the scale of 2 inches = 1 mile.

18. No. 4 Party.—This party continued in abeyance until June 1920, when preparations for taking the field were commenced. Later, however, it was decided that the party should not take the field, and these preparations were discontinued in September 1920.

19. Training.—17 pupil surveyors were entertained and, in addition, 5 vacancies caused by resignation and discharge of men entertained in 1918 and 1919 were filled up by recruitment of new men, thus

making a total of 22 men. Of these 18 were under instruction in drawing and 4 in computations as pupil computers during recess, at the close of which the pupil surveyors will take the field with No. 2 Party for training in survey. The pupil surveyors entertained in 1918 and 1919, who received training in the plains in No. 2 Party, were distributed for further training in hill survey during the coming field season as follows: —

To No. 1 Party ... 16 men
" " 3 " ... 16 "

The soldier surveyors undergoing their first period of training were posted as follows for training in survey during the coming field season :—

4 men (1st year) to No. 2 Party. (Plains)
5 men (2nd year) to No. 1 Party. (Hills)
5 men (2nd year) to No. 3 Party. (do.)

20. Recess Work.—The progress of fair-mapping was retarded owing to the special drawing which had to be undertaken by this Circle on a number of the N.W. Frontier sheets in connection with additional surveys done recently on those sheets by the Waziristān Survey Party, and by special mapping connected with East Persia.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1920 :—

Sheets on the 1-inch scale	...	21
Sheets on the 2-inch scale	...	16
Sheets on the ½-inch scale ...	...	2
Town guide Maps ...	...	2

21. Record Section.—This section has been formed for the preparation of triangulation data and charts for publication of the triangulation pamphlets. It also deals with the custody and issue of triangulation and traverse records, printed maps, office copies of printed maps, original plane-table sections and office forms &c.

22. Particulars of special work done by Nos. 1, 2, 3, 22 and the Sind-Sāgar Parties will be found on pages 18, 42 and 43.

SOUTHERN CIRCLE (*vide* Index map No. 1).

23. No. 5 Party.—This party surveyed an area of 3,027 square miles on the scale of 1 inch = 1 mile in the Chhindwāra, Seoni, Narhsinghpur and Bālāghāt districts of the Central Provinces. The country consisted of jungle-clad hills and well-wooded cultivated plains.

24. No. 6 Party.—This party surveyed an area of 4,191 square miles on different scales in the Bijāpur and Dhārwār districts of Bombay, the Bellary district of Madras and the Raichūr, Mahbūbnagar and Atrāf-i-balda districts of Hyderābād (Deccan), and triangulated an area of 60 square miles in the Atrāf-i-balda districts of Hyderābād, (Deccan). The country surveyed is mostly undulating and cultivated, except the wooded hills of the forest areas.

25. No. 7 Party.—This party did not take the field during the year, but remained in Bangalore engaged on half-inch mapping and the preparation of triangulation pamphlets and charts from materials supplied by this and other parties of the Southern Circle.

26. No. 8 Party.—This party surveyed an area of 4,673 square miles on the scale of 1 inch = 1 mile in the Tinnevelly and Rāmnād districts of Madras. The area surveyed comprised undulating plains, highly

cultivated and thickly dotted with tanks and scattered huts and villages. In the coastal tracts there were numerous patches and belts of palmyra palms, which were a marked feature of the country.

27. Training Section.—After a preliminary course of instruction in the vicinity of Bangalore in plane-tabling for about a month and a half, 20 pupil surveyors were given instruction in field surveys on the scale of 1½ inches = 1 mile in the Anantapur district of Madras about 100 miles north of Bangalore. At the close of the field season in April 1920 six of these pupils were sufficiently advanced to be transferred to parties in recess and seven more, after further training in No. 4 Drawing Office, were sent to parties in August to assist in the drawing of fair maps. Of the remaining seven two were discharged and five were considered likely to be efficient detail surveyors after further training in field work during next field season. The training of eight probationers for the Upper Subordinate Service was taken up in May 1920 but at the close of the survey year only three of these were considered suitable for final retention and the remainder were permitted to resign their appointments.

28. Recess Work.—The fair maps of the whole area surveyed this year, with the exception of 4 half-inch sheets of No. 6 Party, have been completed. These sheets will be finished long before the next recess season, as that party is not taking the field during 1920-21. Half-inch mapping from published modern one-inch sheets and quarter-inch mapping are dealt with on page 39.

29. The report on the survey of cantonments and military stations undertaken by No. 20 Party appears on pages 18 and 19.

EASTERN CIRCLE (*vide* Index map No. 1).

30. No. 9 Party.—This party surveyed an area of 2,344 square miles on the scales of 1½ inches and 1 inch=1 mile in the neighbourhood of Calcutta, work falling in districts Nadiā, Jessore, Khulnā, Twenty-four Parganas, Hooghly and Howrah.

The country surveyed, being in the plains of Bengal, is absolutely flat and covered with marshes, *bils* and tanks; it is densely populated and the villages are large and well wooded; the country immediately round Calcutta and along both banks of the Hooghly is congested with buildings and factories.

The city of Calcutta was not resurveyed, but reductions were taken from the latest large scale maps and revised on the ground.

Towards the south work reached the Sunderbans area, where the country is cut up with tidal rivers and creeks.

31. No. 10 Party.—This party surveyed a total area of 3,239 square miles on the scales of 1 inch and ½ inch = 1 mile, in the Myitkyinā, Putao and Upper Chindwin districts and unadministered territory of Upper Burma. In Myitkyinā and Upper Chindwin districts, the area surveyed consisted mostly of hills covered with dense forest growth, ranging in altitude from 700 feet in the valley of the Uyu river to 11,000 feet above mean sea level on the Kumon Bum range. In Putao district the area comprised a portion of the drainage of the Mali Hka and 'Nmai Hka rivers and ranged in altitude from 1,000 feet to 19,000 feet.

A camp of three surveyors, under an Upper Subordinate officer, remained in Putao district during the summer to complete the detail survey of that portion of the district usually under snow in the winter.

32. No. 11 Party.—Survey operations were continued in Lower Burma, in the Mergui district where 1,631 square miles were surveyed on the scale of 1 inch = 1 mile, and 1,629 square miles were triangulated in advance for detail survey.

The party also surveyed, for military requirements, 103 square miles of country in the Hanthawaddy district, on the scale of 3 inches = 1 mile (*Vide* page 44).

A surveyor was also deputed to accompany the Assistant Superintendent, North Hsenwi, Northern Shan States, for the demarcation and resurvey of a portion of the Burma-China boundary in the Kokang district. (*Vide* page 44).

The country surveyed in the Mergui district comprises the upper reaches of the Ngawun stream hitherto *terra incognita*, Kesseraing island, and the lower basin of the Lenya river. The inland portion consists of intricate hills rising to 4,000 feet in elevation at the main watershed. Both hills and valleys are densely wooded. Towards the sea coast the country is cut up by numerous creeks and fringed with mangrove swamps.

33. No. 12 Party.—This party surveyed an area of 1,967 square miles on the scales of 2 inches, 1 inch and ½ inch = 1 mile, in the districts of Lakhimpur, Bālipārā Frontier Tract, Khāsi and Jaintiā Hills, Sylhet, Cāchār and Nowgong. An area of 1,801 square miles of triangulation and 232 linear miles of traversing, covering an area of 173 square miles, was carried out in the districts of Khāsi and Jaintiā Hills, Sylhet, Cāchār, Nowgong and Nāgā Hills in advance of detail survey.

The area surveyed in the districts of Lakhimpur and Sylhet was flat country partly covered with dense jungle and partly cultivated. The remaining districts consisted of partly open and partly densely wooded hills rising to about 6,000 feet.

34. No. 21 (Burma Forest) Party.—Particulars of work done by this party will be found on page 17.

The area, over which operations extended, is hilly with forest growth of varying density.

35. Recess Work.—Only 1 one-inch sheet out of 31 one-inch and half-inch sheets surveyed during the year under report, was received in the circle drawing office for publication up to 30th September 1920. Most of the remaining sheets will be fair-mapped by the parties before the close of this recess season.

The fair-mapping of 2 half-inch sheets of season 1917-18 and 5 one-inch and 2 half-inch sheets of season 1918-19 was in arrears on 30th September 1920.

II.—FOREST SURVEYS.

36. Details of the topographical surveys of reserved forests executed by field parties of the Survey of India for the year under report are given below. In the majority of cases the surveys were carried out on the scale of 2 inches = 1 mile, but in special cases the 4-inch and 1 inch = 1 mile scales were used. Boundary surveys were made where required and plots prepared on the 4-inch scale.

NORTHERN CIRCLE.

37. United Provinces. Kumaun Forest Circle.—The following areas which include non-forest areas were triangulated in advance for future detail surveys on the 2-inch scale:—

In the *North Garhwāl Forest Division*	...	280	square	miles.
South „ „ „	...	480	„	„
East Almorā „ „	...	220	„	„
Rānīkhet „ „	...	88	„	„

In addition detail surveys on the scale of 2 inches = 1 mile were carried out as follows.

In the *Nainī Tāl Forest Division*	...	36	square	miles.
Central Almorā „ „	...	248	„	„
East Almorā „ „	...	57	„	„
Rānīkhet „ „	...	155	„	„

Western Forest Circle.—No surveys were carried out in this circle during the year, but some additional expenditure in connection with the survey of 1918-19 in the *Chakrātā Forest Division* was incurred during the year under report.

SOUTHERN CIRCLE.

38. Madras. Southern Forest Circle.—In the *Tinnevelly Forest Division* 1·8 and 1·1 square miles were surveyed on the 2-inch scale of the Mīlavittān, and Valliyūr and Extension Reserved Forests respectively.

EASTERN CIRCLE.

39. Assam. Western Forest Circle.—In the *Cāchār Forest Division* 133 square miles of the North Cāchār and Barail Reserved Forests were surveyed on the scale of 2 inches = 1 mile, and 27·2 miles of boundaries were traversed of these Reserves including that of Krungmin. In the *Khāsi and Jaintiā Hills Forest Division*, 62 square miles of Blocks I and II of the Narpuh Reserved Forest were surveyed on the scale of 2 inches = 1 mile, and 33·8 miles of their boundaries were traversed.

Eastern Forest Circle.—In the *Lakhimpur Forest Division* 80 square miles of the Dulong, Kakoi and Rangā Reserved Forests were surveyed on the scale of 2 inches = 1 mile, and 60·8 miles of the boundaries of the two latter Reserves were traversed. In the *Nowgong Forest Division* 21·4 miles of the boundaries of Rangkhang, Habaipur and Barpāni Reserved Forests were traversed, and an area of 13 square miles of the last named Reserve was surveyed on the scale of 2 inches = 1 mile.

40. Burma. Tenasserim Forest Circle.—In the *Tenasserim Forest Division* an area of 281 square miles of the Ngawun Chaung Reserve was surveyed on the scale of 1 inch = 1 mile.

No. 21 Party.—Burma. Northern Forest Circle.—In the *Katha Forest Division*, 6·1 miles of the boundary and 16·8 miles of interior lines of the Mezabya Reserve were traversed as a preliminary to future detail survey. In the *Mansi Forest Division*, 14 miles of the boundary and 7·5 miles of interior lines of the Mode and Hwelit Reserves were traversed, and in addition an area of 34·7 square miles was surveyed on the 4-inch scale of the whole of the Reserve of Nansiaung and three Extension Blocks and parts of Chaunggyibya and Mode.

Southern Forest Circle.—In the *Meiktila and Southern Shan States Forest Divisions* areas of 70·4 and 12 square miles were surveyed on the 2-inch scale respectively of the following Reserves:—Myittha, Pyinyaung, Yebokson East and West Blocks, which were completed, and Magwe of which only a portion was surveyed. Traverses of 149·8 miles of the forest boundaries and 13·8 linear miles of interior lines were carried out in the Reserve of Yupadaung of the former division and in Magwe, Wetpyuye and Kalaw Reserves of the latter division.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

41. No. 1 Party.—An area of 24·7 square miles of Lahore City and environs was surveyed on the scale of 12 inches to a mile from new aerial mosaics prepared by the party; 10·9 square miles of Ferozepore City and environs were also surveyed on scales of 16 inches and 6 inches = 1 mile from similar aerial mosaics. Details of the Mussoorie survey will be found on page 42.

42. No. 2 Party.—The fair drawing of the "Town Guide" and "Environs" maps of Agra, Allahābād, Benares and Cawnpore has been completed and the maps submitted for publication.

Considerable delay occurred in the supply of the prints required from the aeroplane survey, carried out in 1918-19, for the preparation of the maps of Lucknow City; this was due to the Royal Air Force squadron being withdrawn for other duties. The fair drawing will not be completed before February 1921. Details of the survey of Mount Abu will be found on page 42.

43. No. 3 Party.—*(Simla Survey Detachment).*—This detachment surveyed an area of 1,270 acres on the scale of 220 feet = 1 inch, completing the area required for the Simla extension scheme. The area surveyed was mapped in 10 sheets by No. 3 Drawing Office, the mapping of 8 sheets of the previous season's survey being completed by the detachment.

44. No. 20 Party.—During the year under report the party completed the survey of the cantonments and military lands of Secunderābād and Bolārum, St. Thomas's Mount, Pallāvaram, Fort St. George, Poonamallee, Cannanore and Velichi military district land, on the 16-inches to a mile scale, and the revision of surveys, executed in 1908-09 of the bāzārs of Secunderābād and Bolārum on the scale of 50 feet to one inch.

The survey of Wellington and military lands, and the revision of Bangalore Civil and Military Station on the scale of 16-inches to a mile, and the bāzārs of St. Thomas's Mount, Poonamallee, Pallāvaram and Cannanore on the scale of 64-inches to a mile are in progress.

The traversing and triangulation of Wellington, Fort St. George and military district lands, Pallāvaram, Velichi military district land, Poonamallee, Cannanore for 16 and 64-inch surveys and the General, Shūle and Halsūr bāzārs of Bangalore have been completed.

Levelling of 57·5 linear miles was undertaken in cantonments on which to base the traverse heights at a cost-rate of Rs. 50·7 per linear mile.

The fair mapping of the following cantonments and military lands have been completed during the year:—Aurangābād, Hosūr, Ahmadnagar, Jhānsi, Manora and Bellary.

49 sheets have been fair mapped and submitted to press and 90 are at different stages of completion.

The out-turn on the 16-inches to a mile scale of original survey was 14,449 acres and of revision survey 1,925 acres, and that on the 64-inches to a mile scale was 441 acres; 57 plans of 943 acres of the Secunderābād and Bolārum bāzārs on the scale 50 feet to 1-inch, originally surveyed in 1908-09, were also revised.

The cost-rate of original detail survey on the scale of 16-inches to a mile was Rs. 1·7 per acre and the average daily out-turn per surveyor 11·2 acres; the cost-rate of revision survey on this scale was Rs. 0·9 per acre, and the average daily out-turn per surveyor 27·50 acres, the

corresponding figures for survey on the scale of 64 inches to a mile being Rs. 19·6 per acre and 1·03 acres per surveyor respectively.

The testing in linear miles per square mile of survey on the 16 and 64-inch scales is 3·6 and 13·4 respectively, and 10 linear miles per square mile for the 50-foot revision.

The cost-rate of revision survey of 57 plans of Secunderābād and Bolārum bāzārs comprising an area of 943 acres on the scale of 50 feet to an inch was Rs. 7·9 per acre; the average daily out-turn of revision per surveyor was 2·3 acres.

The cost-rate of triangulation and traversing for all scales of survey was Rs. 0·18 per acre, the daily out-turn per traverser being 9 stations and 0·8 linear miles, the number of stations being 13 to a linear mile.

The daily out-turn of traversing for the 50 feet to the inch original survey of bāzārs in Bangalore was 15 stations and 0·48 linear miles; the number of stations being 31 to a linear mile.

The total area fair-mapped was 12,988 acres on the 16-inch scale and 164 acres on the 64-inch scale, and corrections and additions to 77 plans of 1,226 acres on the scale of 50 feet to the inch were completed.

The cost-rate of fair-mapping on the 16-inch scale was Re. 0·6 per acre, that for the 64-inch scale being Rs. 5·9 per acre.

The cost-rate of correcting 77 fair sheets on the 50-foot scale of surveys executed in 1908-09 of the Secunderābād and Bolārum bāzars was Rs. 3·3 per acre.

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scale of 16 and 64 inches = 1 mile, up to the end of 1919-20.

(1)	Agar	Cantonment and Bāzār.	(22)	Kamptee	Cantonment and Bāzārs.
(2)	Bakloh	do.	(23)	Landour	do.
(3)	Balūn (Dalhousie)	Cantonment.	(24)	Meerut	do. and Bāzār.
(4)	Bannu	Cantonment.	(25)	Nasīrābād	do. do.
(5)	Chaman	do.	(26)	Nīmach	do. do.
(6)	Chitrāl	Station.	(27)	Peshāwar	do. do.
(7)	Dehra Dūn	Cantonment.	(28)	Quetta	do.
(8)	Delhi New	Cantonment do.	(29)	Quetta	Fort.
(9)	Deoli	Cantonment do.	(30)	Quetta	Civil Station.
(10)	Drazinda	Out Post.	(31)	Rājkot	Cantonment.
(11)	Drosh	Cantonment.	(32)	Rāwalpindi	do.
(12)	Erinpura	do. do.	(33)	Sahāranpur	Remount Depôt.
(13)	Ghairat	Station.	(34)	Sanāwar	Cantonment.
(14)	Guna	Cantonment do.	(35)	Saugor	do.
(15)	Hangu	do.	(36)	Siālkot	do.
(16)	Hāpur (Bābūgarh)	Remount Depôt.	(37)	Simla	Indian Infantry Lines.
(17)	Jandola	Out Post.	(38)	Sītābaldī	Fort (Nāgpur).
(18)	Jatta	do.	(39)	Thal	Cantonment.
(19)	Jhelum	Cantonment and Bāzār.	(40)	Thath	Camp area.
(20)	Jullundur	do. do.	(41)	Topa	Cantonment.
(21)	Kālka	do.	(42)	Zām	Out Post.

IV.—THE TRIGONOMETRICAL SURVEY.

GEODETIC OPERATIONS.

45. No. 13 Party.—Astronomical.—No latitude operations were carried out during the year under report. The personnel of this party was employed at the Head Quarters Office of the Trigonometrical Survey for the greater part of the year but during February and March 1920 was employed on aeroplane survey at Agra and surrounding area, *vide* page 12.

46. No. 14 Party.—Pendulum.—No pendulum operations were carried out during the year under report and the personnel of this party was reduced to a minimum and employed in miscellaneous work.

47. No. 15 Party.—Triangulation.—The party did not take the field during field season 1919-20.

48. No. 16 Party.—Tidal Operations.—During the year under report tidal registrations were carried out by means of self-registering tide-gauges at the stations given in the following list:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1. Aden	1879 ...	Still working	41	
2. Karāchi	1868 ...	1880	*13 } 52	*With a small tide-gauge.
	1881 ...	Still working	39 }	
3. Bombay (Apollo Bandar)	1878 ...	,,	42	
4. Bombay (Prince's Dock)	1888 ...	,,	32	
5. Madras	1880 ...	1890	10 } 35	
	Restarted 1895	Still working	25 }	
6. Kidderpore ...	1881 ...	,,	39	
7. Rangoon ...	1880 ...	,,	40	
8. Moulmein ...	1880 ...	1886	6 } 17	
	Restarted 1909	Still working	11 }	
9. Port Blair ...	1880 ...	,,	40	

In addition to the above, the actual records of high and low water at Bhaunagar, Chittagong and Akyab were obtained from tide-pole readings taken during daylight by the Port Officers concerned.

Hourly readings throughout the day and night were carried out at Basrah on an ordinary wooden tide-pole by the Military authorities, and a copy of these readings was supplied weekly throughout the year to this department by the Director, Inland Water Transport, Mesopotamia. The observations for the year commencing 1st January 1919 were reduced by the method of harmonic analysis, and the constants thus deduced were used in the computations of data for the Basrah tide-tables for 1921.

These data were forwarded on the 18th December 1919 to the Director, National Physical Laboratory, Teddington, England, for the preparation of the tide-tables with the aid of the tide-predicting machine.

The tide-tables for 1921 have not been received as yet.

Tidal registrations at the nine observatories now working have, on the whole, been carried out satisfactorily and will be continued during the coming year.

The above observatories were all inspected during the year under report, and, in addition, the proposed site for a tidal observatory at Tavoy was also inspected. This was found to be unsuitable, and as no other suitable site was located, the question of a tidal observatory at Tavoy is being held in abeyance by the Burma Government.

49. The following table shows the annual and decadal percentages of errors in the predicted times and heights of high and low water at the 9 stations where observations have been taken by self-registering tide-gauges :—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

Year.	AT OPEN COAST STATIONS.					AT RIVERAIN STATIONS.				
	Number of Stations.	IN TIME. Within 15 minutes of actuals. H.W.—L.W.		IN HEIGHT. Within 8 inches of actuals. H.W.—L.W.		Number of Stations.	IN TIME. Within 15 minutes of actuals. H.W.—L.W.		IN HEIGHT. Within 8 inches of actuals. H.W.—L.W.	
1910	6	81	83	98	98	3	57	52	68	71
1911	6	84	84	98	99	3	65	51	68	66
1912	6	82	82	97	98	4	70	58	74	62
1913	6	83	82	97	97	4	68	55	70	58
1914	6	77	79	96	97	3	75	67	71	55
1915	6	82	82	98	98	3	76	66	73	67
1916	6	81	82	96	97	3	81	68	73	62
1917	6	75	72	96	98	3	78	65	69	64
1918	6	83	82	97	97	3	76	63	66	65
1919	6	78	75	96	97	3	74	65	70	69
Average of ten years	...	81	80	97	98	...	72	61	70	64

Year.	AT OPEN COAST STATIONS. IN HEIGHT. Within $\frac{1}{10}$ of mean range at springs. H.W.—L.W.		AT RIVERAIN STATIONS. IN HEIGHT. Within $\frac{1}{10}$ of mean range at springs. H.W.—L.W.	
1910	95	96	89	94
1911	97	98	90	90
1912	97	98	94	91
1913	98	99	94	88
1914	98	98	92	84
1915	96	96	94	92
1916	96	99	93	87
1917	96	97	92	88
1918	97	96	90	89
1919	97	98	93	92
Average of ten years	97	98	92	90

50. No. 17 Party.—Levelling.—Two double detachments were employed during the past season on the levelling operations mentioned below :—

(a) & (b).—In the Punjab.

Revision of the line from Ferozepore *viâ* Moga and Jagraon to Ludhiāna along the Ludhiāna-Ferozepore road. (Part of line 61).

New line from Amritsar *viâ* Jullundur and Phillaur to Ludhiāna along the Grand Trunk road. (New line 56 F). This is part of line 137 of the New Level Net.

(c) & (d).—In the Sind-Sāgar Doāb.

New line from Shāhpur T.S. *viâ* Leiah and Khairāwāla to Shorkot Road railway station.

New line from Khairāwāla *viâ* Jandānwāla to near Wānbhachrān railway station.

(e) & (f).—In Assam and Bengal.

Revision of the line from Silchar *viâ* Karimganj to Comilla (Line 77 H and part of 77 F).

(g).—In the U. P.

Revision of the section Bareilly to Lucknow (Part of line 64).

Lines (*a*) and (*b*) were undertaken owing to loss of bench-marks on old lines and to complete circuits.

Lines (*c*) and (*d*) were new lines levelled at the request of the Irrigation Department of the Punjab.

Lines (*e*) and (*f*) were relevelled to ascertain whether any crustal subsidence had taken place during the Srimangal earthquake of 8th July 1918.

Line (*g*) was revised owing to the loss of old bench-marks due to time.

The total out-turn was 358 miles of primary levelling of high precision and 424 miles of secondary levelling of precision.

The heights of 16 primary and 534 secondary bench-marks were determined.

Very interesting results were obtained by the relevelment of the Silchar-Comilla line, which showed that definite subsidence had occurred on one side of the geological fault in the earthquake area.

A system has been drawn up by which it is hoped that in future all levelling asked for by the Irrigation, Public Works, and other government departments can be undertaken within a reasonable time on payment by the departments concerned.

51. No. 19 Party.—Base Line Operations.—No work was undertaken by this party during the year under report. The officers and establishment posted to it from time to time for administrative purposes were employed on miscellaneous work.

MAGNETIC SURVEY.

52. No. 18 Party.—Magnetic.—Since the magnetic elements undergo very appreciable changes within a short space of time, it was decided to take observations at the repeat stations at intervals of every five years in order to obtain reliable values of the annual changes; hence the repeat stations, which were observed at in 1914-15, were visited again in 1919-20. Three detachments were employed in completing the field season's programme which comprised observations to determine the declination, dip and horizontal force at the 75 repeat stations in India, Burma and Ceylon and at 5 new stations which were selected this season and permanently marked, two being in Upper Burma, one in Lower Burma, one in Bengal and one in Assam: these 5 extra stations were much needed for shaping the true course of the lines of equal annual change in these particular localities. Complete sets of observations were also taken at the Dehra Dūn, Toungoo, Kodaikānal and Alibāg observatories for the comparison of instruments.

Publication of the results of the Magnetic Survey to epoch.

It is regretted that the publication of the results of the magnetic survey from 1901 to 1915 and reduced to the epoch 1909·0 , which was promised last year, will not be available before the coming year. It has been considered advisable to revise the constants of all the instruments employed, in order to obtain a more accurate determination by utilizing the additional data derived in recent years. It has now, therefore, been decided to recompute the results with greater refinement, and, as observations have been taken this season at the repeat stations, to include all the recent observations and bring the publication up to 1st January 1920.

The reduction of the observations of the detail survey will next be taken in hand and revised. The results of the disturbed areas will then be studied to ascertain whether these areas exhibit any prominent magnetic features. It is doubtful, however, whether the investigation of the latter results will reveal any definite sources of attraction as the

observations in the disturbed areas are very conflicting and appear to show that the disturbances are of a purely local nature, depending entirely upon the unequally magnetized rocks hidden close below the ground surface.

The Magnetic elements at the observatories.—The computation and tabulation of the values of declination, dip, horizontal force and vertical force for the three observatories (Dehra Dūn, Toungoo and Kodaikānal) for the year 1919 have been completed: the mean values of these elements derived from all days, excluding those of great disturbances, are given in the table below:

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1919

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	°	′ ′	C. G. S.	C. G. S.
Dehra Dūn	30 19 19 N 78 3 19 E	N 44 54·8	E 1 56·1	·32962	·32863
Toungoo ...	18 55 45 N 96 27 3 E	N 23 8·3	W 0 20·2	·39097	·16707
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 33·5	W 1 44·5	·37753	·03010

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

53. Brief reports of the work carried out during the year under review in the six offices administered by the Map Publication Office are given in paras. 56 to 60, 67, 68 and 73.

Work under war conditions ceased shortly after the commencement of the year; the requisitions by the Army for maps, &c., have largely diminished in consequence. The demand for instruments has, however, remained much above the normal.

54. No. 6 Drawing Office at Simla was placed under the Superintendent, Map Publication, during the year.

55. The classes of maps for the publication of which the Head Quarter Offices are responsible are as follows:—

(*a*) Topographical maps on the scale of 1 inch =1 mile.
(*b*) Topographical maps on the scale of ½ inch =1 mile.
(*c*) Topographical maps on the scale of ¼ inch=1 mile.
(*d*) Geographical maps on the 1:1,000,000 scale (about 1 inch =16 miles).
(*e*) Geographical maps on the 1:2,000,000 scale (about 1 inch =32 miles).
(*f*) General maps on smaller scales.
(*g*) Special maps.

The progress made in the publication of each of these classes is detailed below:—

(a) **Topographical maps on the scale of 1 inch =1 mile.**—During the year 104 modern sheets have been published. This is a considerable increase on the number published during the previous year.

Index map No. 2 at the end of this report shows the progress made in the publication of the modern 1-inch public sheets, and the following table gives the annual output of these sheets since the modern topographical surveys were begun:—

Years of Publication.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
1915-16	85	69	50	204
1916-17	23	40	22	85
1917-18	18	12	13	43
1918-19	32	19	6	57
1919-20	15	37	52	104
Total Published	691	491	501	1,683
Probable number of 1-inch sheets which will not be published owing to the area covered by them being included in the programme for survey and publication on the ½-inch scale	911	564	473	1,948
Approximate number remaining for publication	550	974	1,063	2,587
Approximate number of public 1-inch sheets in India	2,152	2,029	2,037	6,218

1 one-inch sheet of those surveyed during 1915-16, 4 one-inch sheets of those surveyed during 1916-17, 9 one-inch sheets of those surveyed during 1917-18 and 31 one-inch sheets of those surveyed during 1918-19, remain to be published.

In addition to the above, preliminary editions (in colours) of 13 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision. 11 "Village boundary" editions of modern one-inch sheets have been published for Local Governments.

94 modern one-inch, 6 preliminary editions of one-inch, and 22 old style one-inch sheets have been reprinted during the year.

(b) **Topographical Maps on the scale of ½ inch=1 mile.**—Index map No. 3 at the end of this report shows the progress made in the publication of the modern half-inch public sheets. This series now forms the *tactical* map of India, having taken the place of the quarter-inch maps in this respect. It was commenced in 1914; most of the sheets published up to date are reductions from the one-inch map, but others are from direct half-inch surveys.

The following table gives the annual output of these sheets:—

Years of Publication.	Number of ½-inch Sheets Published.		
	Drawn from component one-inch sheets.	Surveyed on half-inch scale.	Total.
1914-15	...	1	1
1915-16	21	4	25
1916-17	50	6	56
1917-18	59	6	65
1918-19	26	4	30
1919-20	**31**	**8**	**39**
Totals	187	29	216
Approximate number of half-inch sheets in India	.....	.....	1,630

In addition to the above, a preliminary edition (in colours) of one half-inch sheet prepared from old half-inch material, has been published during the year.

3 modern public half-inch sheets have been reprinted during the year.

(c) **Topographical maps on the scale of ¼ inch=1 mile.**—These maps are prepared in "degree" sheets which include 1° of latitude and 1° of longitude, *i.e.*, the area covered by 16 one-inch sheets, or 4 half-inch sheets.

The production of these maps is still delayed owing to the more urgent work on those of the half-inch scale.

Index map No. 4 at the end of this report shows the progress made in the publication of the modern quarter-inch public sheets.

The following table gives the annual output of these sheets:—

Years of Publication.	Number of "Degree" Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	1	3	3	7
1915-16	...	1	4	5
1916-17	1	...	3	4
1917-18	...	...	4	4
1918-19	...	3	8	11
1919-20	**4**	...	**4**	**8***
Totals	15	12	33	60†
Approximate number of "degree" sheets in India	170	140	140	450

* 7 of these were drawn in No. 1 Drawing Office.

† 20 of these are preliminary editions, having been prepared from surveys (on various scales) prior to 1905.

7 preliminary sheets in colours from comparatively modern surveys have been published and 11 are in hand.

In addition to the above, 1 modern public quarter-inch sheet has been reprinted during the year.

14 "degree" sheets have been prepared in No. 1 Drawing Office from the old engraved quarter-inch Atlas sheets, brought up to date and published (in black only) as provisional issues; and 8 of such sheets which were published previously have been reprinted during the year. These "provisional" degree sheets, including those in hand, now cover the greater part of the area of India for which modern "degree" sheets are not likely to be available for some time.

(d) **Geographical Maps on the 1:1,000,000 scale.**—(*i*) **The "India and Adjacent Countries" Series** (*Vide* Index map No. 5).—During the year 2 new sheets of this series have been published, 3 sheets have been engraved and 6 modernized and republished to supersede old editions, and 23 sheets have been reprinted.

(*ii*) **La Carte Internationale du Monde.**—(*Vide* Index map No. 6).—A full description of the genesis of this series was given in the General Report for 1913-14; 3 sheets of this series have been published during the year, 8 sheets have been published up to date.

(e) **Geographical Maps on the 1:2,000,000 scale.**—(*Vide* Index map No. 7).—No new map of this series was published during the year. It has been decided to engrave the sheets of this map on two plates only, one for outline and one for the hill features.

(f) **General Maps on smaller scales.**—The engraved plates of all these maps have been corrected and brought up to date as far as possible during the year.

(g) **Special maps.**—The annual edition of the Railway Administration map (on the scale of 1 inch = 64 miles) has been published during the year; two provincial maps and the map of India and Adjacent Countries (on the scale of 1 inch = 64 miles) have been reprinted.

Numerous special maps have also been prepared and printed for the Army, for Local Governments and for other Departments.

"Town-guide" maps, on the scale 12 inches = 1 mile, of several of the larger Indian cities are under preparation; the Calcutta-Howrah "Town-guide" map (in 16 sheets) was completed during the year, also the maps of Rāwalpindi and Campbellpore.

The maps Simla Mahasu (in 10 sheets) and Simla Mashobra (in 14 sheets) on the scale of 220 feet to 1 inch of the Simla extension surveys have been published.

A map of Bombay City (in 12 sheets) was published on the scale of 400 feet to 1 inch from reductions of the Bombay City Surveys of 1914-1918.

56. Map Record and Issue Office.—An Imperial Officer was attached exclusively to this office during the year. The work is being placed as far as possible on a commercial basis and considerable changes in the routine methods have taken place.

To meet the demands for more up to date information in respect of the maps that are available, a new catalogue is under preparation and will be issued early next year.

The reduction in demand is due to the cessation of military operations.

The issues on cash payment still increase steadily.

Issues.—FROM MAP RECORD AND ISSUE OFFICE, 1919-20.

YEAR.		ON BOOK DEBIT (TO GOVERNMENT OFFICIALS).		ON CASH PAYMENT (TO PRIVATE INDIVIDUALS AND MAP AGENTS).		FREE ISSUES (DEPARTMENTAL AND TO INDIA OFFICE).		TOTAL.	
		Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.
1919-20	Departmental.	108,027	59,290	35,683	41,086	48,190	41,157	191,900	1,41,533
	Extra-departmental.	1,163,824	1,07,533	101,288	14,382	28,854	9,702	1,293,966	1,31,617
	Total ...	1,271,851	1,66,823	136,971	55,468	77,044	50,859	1,485,866	2,73,150
1918-19 -	Total ...	2,227,010	3,87,085	101,222	47,663	37,204	32,539	2,365,436	4,67,287
1917-18 -	Total ..	795,810	2,12,861	39,183	35,795	48,550	39,382	883,543	2,88,038

Table IV.—Publications received in Map Record & Issue Office, 1919-20.

A.—From the Calcutta Printing Offices, (including the Engraving Office).

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	Reprints and New Editions.		
		DEPARTMENTAL.			
GENERAL MAPS.					*Rs.*
Maps of India	Various	...	4	3,900	8,000
GEOGRAPHICAL MAPS.					
Map of India	1″=32 *miles*	...	...	...	...
Southern Asia Series	1:2,000,000	...	...	...	...
India and Adjacent Countries Series	1:1,000,000	2	32	21,500	21,500
La Carte Internationale du Monde	1:1,000,000	3	...	900	900
TOPOGRAPHICAL MAPS.					
Quarter-inch Modern	1″=4 miles	1	1	2,000	2,000
Do. (Prely.)	1″=4 miles	7	...	8,540	9,210
Do. (Provl.)	1″=4 miles	14	8	8,700	8,676
Half-inch Modern	1″=2 miles	39	3	21,990	22,496
Do. (Prely.)	1″=2 miles	1	...	500	563
One-inch Modern	1″=1 mile	104	94	115,955	115,309
Do. (Prely.)	1″=1 mile	13	6	8,515	8,893
Old Style sheets	Various	...	35	6,310	8,510
SPECIAL MAPS.					
District Maps ...	1″=4 miles	...	...	...	...
Administration Report Maps ..	1″=8 miles	...	4	173	65
Provincial Maps	Various	...	2	1,150	1,386
Plans of Cities and Cantonments ...	Various	33	11	6,500	9,863
Index Maps	Various	3	38	49,900	7,738
Miscellaneous Maps	Various	12	22	8,473	8,244
Total	.....	232	260	265,006	233,353
		EXTRA-DEPARTMENTAL.			
Maps	Various	135	43	292,159	94,540
Plans and diagrams	Various	95	10	147,413	16,865
Illustrations	.....	93	16	192,254	28,634
Miscellaneous	.....	41	49	562,639	19,528
Total ...	.....	364	118	1,194,465	1,59,567
Grand Total	.....	596	378	1,459,471	3,92,920

B.—From the Trigonometrical Survey Office, Dehra Dūn.

Various	.....	37	17	4,165	4,165

C.—LETTERPRESS.

1. Survey of India General Report, 1918-19. *Price Rs. 2 or 4s.*

57. No. 1 (Head Quarters) Drawing Office.—This office is divided into six sections each under its own supervising officer.

(1) *The Compilation Section.*—Deals with "La Carte Internationale du Monde au 1,000,000," with all "Geographical" maps on scales smaller than the 1:1,000,000, and with miscellaneous work.

(*a*) "La Carte Internationale du Monde au 1,000,000". One sheet has been sent to press, another is ready for the press and patterns for the engraving of four sheets are under preparation.

(*b*) The Southern Asia Series, scale 1:2,000,000. Patterns for the engraving of five sheets are at different stages of completion.

(*c*) The most important "miscellaneous" maps dealt with by this section have been the "Town-guide" map of Nowshera which has been completed and sent to press, and the map of the island of Bombay originally prepared in 12 sections by the Bombay City Survey which was rearranged into 10 sections, and the sheets sent to press.

In addition to the above this section also prepared and sent to press the following:—(*i*) index, on 1/5 M scale showing surveys and publications of 1-inch sheets (*ii*) border specimen for 1-inch, ½-inch and ¼-inch sheets and (*iii*) the stump shaded originals of 3 one-inch sheets. The preparation of a revised type table for topographical maps is also in hand.

(2) *The "One-Millionth" Section.*—Is responsible for all maps of the "India and Adjacent Countries" Series on the 1:1,000,000 scale.

(*a*) Engraved Editions.—The patterns for six sheets have been completed and sent to the Engraving Office and those for four sheets are still in hand.

(*b*) Helio Editions.—One sheet has been completed and sent to press and another is in hand.

(*c*) The originals of ten sheets have been corrected and sent to press for reprint.

(3) *The Quarter-Inch Section.*—This section deals with the fair drawing of quarter-inch sheets, either as "Preliminary" editions or as "Provisional" issues compiled mainly from surveys on different scales executed prior to 1905.

(*a*) Nine "Preliminary" editions have been sent to press and nine "Preliminary" and four "Provisional" sheets are in hand.

(*b*) During the year under report the correction of 6 original fair sheets for reprint was in hand, 3 have been sent to press.

(4) *The Mapping and Reprint Section.*—Deals mainly with the corrections of fair sheets (both modern and old style) for reprint and also with the fair mapping required for all special maps (whether Departmental or Extra-departmental) on all scales. The latter include a Railway guide map for the Oudh and Rohilkhand Railway and an improved form of grid indicator cards for military purposes.

(*a*) The fair sheets of 211 published sheets (170 modern and 41 old style) on the 1-inch, ½-inch and ¼-inch scales have been corrected and brought up to date and sent

to press for reprint. In addition 15 fragmentary sheets have been completed to edge from old material as far as possible and 5 sheets have been enlarged, corrected and brought up to date. and sent to press for publication in colours.

(*b*) The fair sheets of 90 new one inch topographical sheets from the different circles and drawing offices received for publication have been scrutinised and corrected before being sent to press.

(*c*) Press order proof corrections have been inserted on the original fair sheets of 144 modern topographical sheets after publication.

(*d*) The fair sheets of 32 special maps on various scales have been drawn for other government departments, etc. and sent to press.

(5) *The Office Copy Section.*—Is mainly employed in maintaining a complete record of all additions and alterations to details on published sheets for incorporation on future editions and reprints of the sheets.

(*a*) Additions and corrections have been entered on the existing "office copies" of 2,808 published sheets; 482 "office copies" of newly published or reprinted sheets have also been prepared during the year.

(*b*) The miscellaneous work of this section includes the checking and recording of the areas surveyed and contained in all one-inch and half-inch fair sheets received in the Map Publication Office for publication and the supply of authenticated copies of records to officials and private persons.

(6) *The Examining Section.*—Is responsible for the examination of the sheets which are drawn by the other sections in the office and also for the general scrutiny of a large number of sheets, fair drawn in other circles and drawing offices, before publication.

(*a*) 176 cases affecting 285 fair sheets have been dealt with by this section during the year.

The variety and amount of miscellaneous work which passes through this section in connection with the fair mapping of the whole department are too large to be separately detailed.

58. Engraving Office.—(1) *Engraving Section.* (*a*) As in the previous year, most of the engravers have continued to be employed on new or modernized editions of maps of the "India and Adjacent Countries" Series, on the 1:1,000,000 scale. Out of seven sheets taken up one has been completed, another has been finished with the exception of the contours, two others are nearing completion whilst the remaining three are well advanced.

Of the "La Carte Internationale du Monde", scale 1:1,000,000, two sheets have been completed and four new sheets projected.

(*b*) Of the Southern Asia Series, on the 1:2,000,000 scale, two sheets *viz.* Madras and Brahmaputra, are well in hand.

(*c*) The new map of India on the 1:4,000,000 scale is in abeyance for the present.

(*d*) Periodic corrections have been carried out on the plates of all the general maps of India on various scales as also on index charts. The new index chart on the 1:6,000,000 scale for the Annual Report (two plates) has been completed. Miscellaneous work is mostly extra-departmental and includes a plate for the Viceroy's certificate printed on vellum for Territorial units serving in India, also six plates of specimens of lettering for apprentice draftsmen, the engraving of various kinds of scales required for the Army, and of titles on a considerable number of photogravure plates. Several old plates have also been repaired.

(2) *Printing Section*—29,040 impressions were pulled during the year compared with 25,544 during the previous year on the same number of machines. Most of these impressions were extra-departmental orders and consisted of 9,430 photogravure prints, 10,041 scales and 3,465 miscellaneous prints on parchment and vellum for the Army Department. Printing on parchment and vellum from plates is a particularly difficult work requiring special care and skill and this year there was a larger order than usual for such prints. Height indicator card scales pulled from copper plates have been printed on both sides of the cardboard; this is the first time that this has been attempted.

151 plates were dealt with in the Steel-facing section.

59. Photo.-Litho. Office.—The Litho. out-turn is somewhat smaller than those of the 3 previous years, there having been a considerable decrease in urgent reprinting orders for the Army since the peace terms have been signed. The output therefore has gone back to normal.

One new litho. machine press was received from England near the end of the year.

Engraved maps in colour are now dealt with photographically, as forecasted last year; although the reproduction is not yet perfect, the saving in time and labour is enormous. For one colour work the transfer method is still probably the better.

New processes have been evolved whereby one or more tints can be added to a helio plate by exposure in the printing frame instead of by transferring in a hand press; layer plates are now made without using a camera, the layer original being prepared on glass instead of on paper.

The following tables briefly summarize the record of the Office for the past 3 years:—

TABLE A.

1	2	3	4	5	6
Year.	Cost of office.	Value of out-turn at cost-rates.	Number of maps printed.		
			Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*			
1917-18	2,08,784	4,34,124	817	3,812	4,629
1918-19	2,21,218	4,54,243	637	4,203	4,840
1919-20	**2,20,643**	**4,19,636**	**786**	**3,118**	**3,904**

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	Type Section Out-turn.		
				Pages or items published.	Copies printed.	Impressions pulled.
1917-18	4,796,813	224,903	1,193,418	7,476	942,811	1,677,147
1918-19	4,248,913	183,413	1,151,678	5,577	1,233,211	1,829,380
1919-20	**3,013,622**	**122,522**	**727,255**	**4,656**	**1,564,552**	**2,742,584**

to press for reprint. In addition 15 fragmentary sheets have been completed to edge from old material as far as possible and 5 sheets have been enlarged, corrected and brought up to date. and sent to press for publication in colours.

(*b*) The fair sheets of 90 new one inch topographical sheets from the different circles and drawing offices received for publication have been scrutinised and corrected before being sent to press.

(*c*) Press order proof corrections have been inserted on the original fair sheets of 144 modern topographical sheets after publication.

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(6) *The Examining Section.*—Is responsible for the examination of the sheets which are drawn by the other sections in the office and also for the general scrutiny of a large number of sheets. fair drawn in other circles and drawing offices, before publication.

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58. Engraving Office.—(1) *Engraving Section.* (*a*) As in the previous year, most of the engravers have continued to be employed on new or modernized editions of maps of the "India and Adjacent Countries" Series, on the 1:1,000,000 scale. Out of seven sheets taken up one has been completed, another has been finished with the exception of the contours, two others are nearing completion whilst the remaining three are well advanced.

Of the "La Carte Internationale du Monde", scale 1:1,000,000, two sheets have been completed and four new sheets projected.

(*b*) Of the Southern Asia Series, on the 1:2,000,000 scale, two sheets *viz.* Madras and Brahmaputra, are well in hand.

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New processes have been evolved whereby one or more tints can be added to a helio plate by exposure in the printing frame instead of by transferring in a hand press; layer plates are now made without using a camera, the layer original being prepared on glass instead of on paper.

The following tables briefly summarize the record of the Office for the past 3 years:—

TABLE A.

1	2	3	4	5	6
Year.	Cost of office.	Value of out-turn at cost-rates.	Number of maps printed.		
			Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*			
1917-18	2,08,784	4,34,124	817	3,812	4,629
1918-19	2,21,218	4,54,243	637	4,203	4,840
1919-20	**2,20,643**	**4,19,636**	**786**	**3,118**	**3,904**

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	Type Section Out-turn.		
				Pages or items published.	Copies printed.	Impressions pulled.
1917-18	4,796,813	224,903	1,193,418	7,476	942,811	1,677,147
1918-19	4,248,913	183,413	1,151,678	5,577	1,233,211	1,829,380
1919-20	**3,013,622**	**122,522**	**727,255**	**4,656**	**1,564,552**	**2,742,584**

TABLE C.

PHOTO. BRANCH.

	1917-18.	1918-19.	1919-20.
Negatives	5,500	4,190	6,658
Zinc Plates	8,426	7,227	9,161
Half-tone blocks ...	380	554	544
Line blocks			

60. Mathematical Instrument Office.—During the year from 1st April 1919 to 31st. March 1920, there was a decrease in the demands made on this office (*vide* item 1 in para. 2), as well as in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 71,839 and Rs. 20,109 against a profit of Rs. 1,21,573 and Rs. 39,762 in 1918-19.

2. Below are given the usual comparative figures for the last 3 years :—

	1917-18.	1918-19.	1919-20.
	Rs.	*Rs.*	Rs.
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	8,88,658	7,64,795	5,54,959
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	53,133	50,904	48,002
3. Value of instruments received from Government Officers when no longer required.	85,209	1,33,730	51,503
4. Book value of the stock of instruments, &c., in Serviceable Stores.	3,92,268	4,22,818	4,06,059
5. Book value of the stock of instruments, &c., in Repairable Stores.	1,04,394	1,10,554	79,057
6. Total value of work done in the Workshop ...	3,41,627	4,35,023	3,67,343
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	1,85,737	2,17,342	1,95,907
8. Value of instruments purchased locally ...	4,30,336	2,72,462	70,276
9. Value of instruments and materials obtained from England through the Director General of Stores.	66,380	67,174	1,57,694
10. Average No. of employees and their pay ...	No. 504, Rs. 1,33,719;	No. 556, Rs. 1,63,759	No. 599, Rs. 1,28,770

3. During the year the stock of all the three stores (the Serviceable, the Repairable and the Material Stores), was twice taken, and the discrepancies noticed have been adjusted.

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

61. Computing Office.—A large amount of computation was done both on departmental and non-departmental requisitions. The adjustments of Mawkmai and Mong Hsat series, Kashmīr series and Russian triangulation have been taken in hand. Great progress has been made in remodelling computation forms and adapting them to paper of foolscap size.

In view of the enormous mass of minor triangulation requiring adjustment, a method shorter than that used in geodetic triangulation must be devised in order to make the work of adjustment practicable. Considerable progress has already been made in finding a shorter method leading to consistent results.

Dr. Hunter also prepared a long note on the specifications of microscope theodolites, in view of certain developments in glass graticules and other details. This has been sent to the Director General of Stores, India Office, by whom it was called for.

165 requisitions for data from departmental and non-departmental officials were complied with.

32 Triangulation pamphlets were published and issued during the year.

Type Printing Section.—The following publications were printed during the year:—

1. Records of the Survey of India. Vol. XIV, 1918-19.
2. Departmental Paper No. 9.
3. Triangulation pamphlets covering 79 degree sheets.
4. Levelling pamphlets, 44, 58 and addenda to levelling pamphlets 63, 72 and 73.
5. Auxiliary Tables, Part I (reprint).
6. Hand Book of Levelling.
7. Catalogue of Library books.
8. Topo. Hand Book, Chapter III.
9. Air Photo. Surveying.
10. Waziristān Report.

Observatories.—Meteorological observations were continued as usual, and the Omori seismograph was in operation throughout the year. Photographs of the sun were taken on 324 days, the sun being obscured on the remaining days of the year.

Preservation of Trigonometrical Stations.—571 stations were repaired by the district officers at a cost of Rs. 3,118. Out of 359 districts from which reports were due, 15 failed to make returns. 9 districts of the Hyderābād State have not submitted annual returns although reminders were sent.

62. No. 2 (Dehra) Drawing Office.—During the year under report the work in this office was carried out by seven sections.

(1) *The Triangulation Chart and Cantonment Section.*—Deals with the fair drawing of triangulation, levelling and index charts, and the

publication, reprint and correction of cantonment plans. In addition to the ordinary work of this section 15 miscellaneous sheets and charts were fair drawn, proved and finally sent to press and 58 sheets were hand coloured.

(2) *The Compilation Section.*—Deals with the compilation and fair mapping of Geographical maps on different scales. Out of 9 sheets on 1:1,000,000 scale, shown as in hand last year, 8 sheets were completed and sent to press and fair mapping of the remaining one is nearly completed. The rough compilation of 5 more sheets on this scale has been taken up this year in addition to that of the 5 sheets shown in hand last year, making 10 sheets in hand. Four sheets with hills of the new Himālayan map on 1:3,000,000 scale shown in hand last year, have been fair mapped and sent to press for publication on 1:2,500,000 scale. The rough compilation of 2 more sheets of the Southern Asia Series on 1:2,000,000 scale was taken in hand during the year in addition to the one shown in hand last year.

(3) *The Stein Section.*—Deals with the fair mapping of Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906-08 and 1913-15. Out of 12 sheets shown in hand last year, 8 sheets were completed and sent to press during the year leaving 4 sheets in hand, which are under scrutiny by Sir Aurel Stein. Of the sheets sent to press for publication 14 sheets are still in the colour proof stage.

(4) *The Half-inch Section.*—This section was formed as a result of the Surveyor General's decision during his inspection last spring that a half-inch mapping section should be re-started in this office. The 4 sheets shown as remaining in hand at the end of last year have been completed and sent to press for publication, and 12 more sheets have been taken in hand.

(5) *The Field Section.*—Mr. P. Davis was appointed from home as a first division draftsman and was attached to this office. This section was formed under him for the training of draftsmen and pupils in the rapid style of drawing field operation maps on the lines of the system adopted in the late campaign in Mesopotamia, and also in drawing outline and doing reverse printing on zinc plates. Fair progress is being made.

(6) *The Examining Section.*—Examines the majority of the important sheets drawn in this office and instructs the pupil draftsmen in drawing, hand printing and in the use of drawing instruments. 72 sheets on various scales were examined and disposed of and a number of specimens of drawing and rapid style hand printing was prepared by this section during the year.

(7) *The Map Record Section.*—Deals with the storage of originals and office copies &c., of cantonment plans, triangulation and other charts and Geographical maps, and keeps a small stock of all maps published by the department for occasional issue to the public and for departmental use; also deals with the despatch of all sheets printed in Dehra Dūn and with all correspondence.

The following is the summary of the work of the office during the year 1919-20:—

Class of maps.	Scale.	Balance of sheets on 1st October 1919.	Sheets received in 1919-20.	Sheets sent to press in 1919-20.	Balance of sheets in hand on 1st October 1920.	REMARKS.
Triangulation charts ..	.....	18	27	34*	11	*Proved and finally sent to press.
Levelling charts scale 1"=16 miles.	.....	.....	5	4†	1	† Do.
Index charts to illustrate reports.	.....	.....	4	4‡	.....	‡ Do.
Cantonment plans for correction.	.....	52	199	198§	53	§Corrections carried out in both originals and office copies and stored.
Cantonment plans for publication.	.....	.....	127	68¶	59	¶Proved and finally sent to press.
Colour guides	.....	10	498	58	450	Includes colouring of cantonment plans.
GEOGRAPHICAL MAPS.						
Scale 1/M Fair sheets ...	.....	9	.....	8	1	
Scale 1/M Rough compilation	.....	5	5	.....	10	
Scale 1/2½M Fair sheets	.....	4	.....	4	.....	
Scale 1/2M Rough compilation.	.... .	1	2	.....	3	For engraved edition.
Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906—08 and 1913—15, for publication on 2/M scale.	.....	12	.	8	4	Of the sheets sent to press previously 14 are in the colour proof stage.
Half-inch sheets ...	.....	4	12	4	12	

Photo.-Zinco. Section.—During the year 1919-20, the work undertaken comprised :—

Cantonment Maps.
Indexes and Triangulation Charts.
Forest Maps.
Sir Aurel Stein's Maps.
Miscellaneous Maps.
Extra-departmental Maps.

In the year under report, the Vandyke section placed at the disposal of the Superintendent Northern Circle, has since returned to Dehra Dūn as the Wazīristān Survey Party was disbanded. A detachment of 4 men (2 litho-draftsmen, 1 photographer and 1 helio-printer) was sent to Baghdād, in order to re-inforce the Mesopotamian Survey Party.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Cyanotype prints.
1917-18 ...	1,130	1,719	345,776	127
1918-19 ...	1,193	1,475	275,276	229
1919-20 ...	**1,414**	**2,087**	**316,114**	**562**

63. Forest Map Office.—The class of work entrusted to the four technical sections of this office has been described in a previous report; the distribution of work has been continued on the same lines, and the progress made during the year is described below :—

(1) *The Drawing Section.*—The progress of this section is shown in the table below :—

Class of map.	In hand on 1st October 1919.	Received during the year 1919-20.	Drawn and sent for publication in 1919-20.	In hand on 30th September 1920.	Published during the year 1919-20.	Total number of copies printed.
(*a*) ...	.....	59	59	.....	55	21,823
(*b*) ...	63	17	48	32	38	
(*c*) ...	17	.....	13	4	6	
(*d*) ...	14	15	21	8	38	
(*e*) ...	.....	13	13	.....	7	
(*f*) ...	36	59	27	68	25	
(*g*) ...	1	29	24	6	42	
TOTALS ...	131	192	205	118	211	

(*a*) Reprints of Forest maps on various scales.
(*b*) Forest editions, on the scale of 2 inches = 1 mile, of modern one-inch maps.
(*c*) Maps of Forest Circles and Divisions.
(*d*) Maps to illustrate working plans, &c.
(*e*) Maps and diagrams to accompany Administration Reports.
(*f*) Forest maps from special surveys, mostly on the scale of 4 inches = 1 mile.
(*g*) Index and miscellaneous maps.

(2) *The Portfolio Section.*—Office copies of 185 maps and colour specimen of 49 maps were prepared, corrections on 191 sheets were completed, and 2,597 sheets were coloured by hand for issue. All arrears regarding office copy corrections to be made from Notifications received to date have now been worked off.

(3) *The Map Record Section.*—The number of maps, diagrams and other records, received for storage was 21,626, and 17,948 maps, &c., valued at Rs. 17,403 were issued. Sales by book-transfer to Government departments amounted to Rs. 9,159 for 13,930 maps, &c., these figures show an increase of 5,940 maps and Rs. 1,907 over those for last year. Cash sales to the public amounted to Rs. 3,725 for 1,745 maps, an increase of Rs. 415 over the amount realised the previous year.

(4) *The Book-Binding Section.*—The section dealt with 352 volumes for the Forest Research Institute and 76 volumes for the library of the Trigonometrical Survey, the value realized being Rs. 1,013, an increase of 103 volumes and Rs. 312 over the figures for last year. In addition 412 envelopes were made for Height Indicator cards and the cost *viz.* Rs. 171 realized by book-transfer; 2,675 maps of various sizes were mounted on cloth for issue.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

64. No. 3 Drawing Office (Northern Circle).—During the year 5 two-inch sheets out of 21 and 19 one-inch sheets out of 40 previously surveyed, were fair-mapped by parties and have been submitted for publication. In addition to these 5 one-inch sheets were redrawn and 3 one-inch sheets were brought up to date and completed to margin in the Circle drawing office and submitted for publication.

Half-inch sheets compiled from modern one-inch and old style half-inch maps.—26 half-inch sheets, 25 of which were drawn in the Circle drawing office, have been submitted for publication during the year.

Modern material available.—There are 89 half-inch sheet areas of which the component one-inch sheets have been published; of these the fair-mapping of 24 sheets is in hand. In addition to the above, there are 9 half-inch sheet areas of which some of the component one-inch sheets, though surveyed, have not been submitted for publication.

Quarter-inch sheets drawn from the published sheets of the modern one-inch and half-inch maps (and old style maps).—During the year, 1 quarter-inch sheet was fair-mapped in the Circle drawing office and submitted for publication. The fair-mapping of 2 quarter-inch sheets is in hand while that of 2 others is in abeyance.

Modern material available.—There are 24 quarter-inch sheet areas of which the component one-inch or half-inch sheets have been published.

In addition there are 3 quarter-inch areas of which some of the component one-inch sheets have not been submitted for publication.

Special maps.—During the year 18 sheets of the Simla Extension Survey, scale 220 feet = 1 inch; 16 sheets Mount Abu Survey, scale 1 inch = 220 feet; 12 sheets Town Guide and Environs Maps Surveys scale 12 inches and 4 inches to a mile respectively; 2 sheets of the biennial survey of Delhi and vicinity map, scale 4 inches = 1 mile and 5 of the Royal Artillery Practice Camp Maps, scale 3 inches = 1 mile, were fair-mapped and submitted for publication.

Hill-shaded sheets.—33 one-inch and half-inch sheets were stump shaded and submitted for publication.

Layer guides.—Nil.

Colour patterns and press order proofs.—Press order proofs and colour patterns of 81 sheets were submitted for publication. In addition to these the yellow and green colour patterns of 27 sheets and the yellow colour patterns of 18 sheets were specially prepared and submitted during the year for future reprint purposes.

Miscellaneous.—The traverse plots of 30 *mauzas* in 54 sheets, scale 16 and 32 inches = 1 mile, of the Gondā district were prepared and the cost of preparation recovered from the Deputy Commissioner, Gondā.

For the purpose of reprint, the office copies of 197 one-inch sheets were corrected, brought up to date and submitted for publication during the year.

The special village boundary editions of 11 one-inch sheets were prepared in the Circle drawing office and submitted for publication during the year.

The fair sheets of 46 half-inch sheets were brought up to date and submitted for reprint during the year.

65. No. 4 Drawing Office (Southern Circle).—During the year, 25 one-inch sheets and 2 half-inch sheets which had been fair-mapped by parties were finally examined and sent for publication. At the end of the year every sheet, the survey of which had been completed during previous years, was submitted for publication.

Half-inch sheets compiled from modern one-inch maps.—2 sheets were fair-mapped and submitted for publication, and 25 sheets which had been fair-mapped by No. 7 Party were finally examined and submitted for publication. At the end of the year 11 sheets were in hand.

Modern material available.—There are 11 half-inch sheet areas completely surveyed on the one-inch scale but of which the component one-inch sheets have not yet been submitted for publication. All half-inch sheets of which all the component one-inch sheets have been so submitted have either been submitted for publication or are in hand.

Quarter-inch sheets compiled from modern one-inch and half-inch sheets (and old style maps).—3 quarter-inch sheets were fair-mapped and submitted for publication.

Modern material available.—There are 9 quarter-inch sheet areas of which all component half-inch sheets have been submitted for publication. In addition there are 6 quarter-inch sheet areas completely surveyed but of which the component half-inch sheets have not yet been submitted for publication; of these the fair-mapping of 12 sheets is in hand.

Special maps.—Revised edition of the Ootacamund Hunt map was fair-mapped. Kāpra and Rājankunti (Royal Artillery Practice Camp) maps were finally examined and submitted for publication.

Hill-shaded sheets.—36 were prepared.

Layer guides.—Nil.

Colour patterns.—Were prepared for 61 sheets.

Triangulation charts.—6 were finally examined and submitted for publication.

Photo.-zinco. work.—

Number of reproductions	... ...	160
,, ,, enlargements	... ...	126
,, ,, reductions	... ...	344
,, ,, Vandyke plates prepared	...	187
,, ,, prints pulled	... ...	9,023

Miscellaneous.—58 plane-table sections of the South-West Persia Survey Detachment were completed as regards headings, scale, &c.; of these 52 on the ½-inch scale were submitted to No. 6 Drawing Office for fair-mapping, 3 on the 1-inch scale, 2 on the 4-inch scale and 1 on the 8-inch scale will be fair-mapped in this office.

The usual training in drawing, typing and hand-printing was given to pupil surveyors and pupil draftsmen.

66. No. 5 Drawing Office (Eastern Circle).—During the year, 12 one-inch sheets and 5 twelve-inch sheets were fair-mapped by parties from recent surveys and received in the drawing office. There were also 25 one-inch and half-inch sheets received from the parties in the previous year which were under examination and correction. Of these 42 sheets, 41 were finally examined and submitted for publication and the remaining one has been scrutinised and is ready to be despatched.

Half-inch sheets compiled from modern one-inch and old style maps.—14 sheets were received from parties in the previous year for final examination, 4 were received in various stages of completion during the

year and 14 were under preparation in the drawing office. Of these 32 sheets, 14 were finally examined and submitted for publication and 18 are in hand.

Modern material available.—There are 68 half-inch sheet areas of which the component one-inch sheets have been submitted for publication; of these the fair-mapping of 32 sheets is in hand in the circle.

Quarter-inch sheets compiled from published sheets of the modern one-inch, half-inch and old style maps.—The fair-mapping on 11 sheets was in hand and 2 sheets, received from the parties in the previous year, awaited final examination. Of these, 5 sheets were submitted for publication during the year and 7 are now in hand. Work on one sheet is held in abeyance pending completion of the component half-inch sheet recently surveyed.

Modern material available.—There are 15 quarter-inch sheet areas of which all component one-inch or half-inch sheets have been submitted for publication; of these the fair-mapping of 3 sheets is in hand.

A rough compilation in one sheet, comprising the area surveyed on the quarter-inch scale by a detachment attached to the Kuki Punitive Measures Force, was prepared and completed to margin by the incorporation of material from old style maps. It was submitted for publication and a small edition will be printed to meet the present requirements of the Assam Government.

Hill-shaded sheets.—Material for 20 one-inch, 14 half-inch and 5 quarter-inch sheets were received. There were also 15 one-inch and half-inch sheets in various stages of completion at the close of the previous year. Of these 54 sheets, 47 were completed and submitted for publication and 7 are in hand.

Layer guides for 4 quarter inch sheets were received of which 2 were completed and 2 are in hand.

Colour patterns and press order proofs.—Proofs for the preparation of 58 colour patterns were received during the year and 25 were in hand at the close of the previous year. A total number of 73 colour patterns and press order proofs were completed and despatched for publication and 10 were in hand on 1st October 1920.

Triangulation charts and traverse data.—A special section was formed during the latter part of the year to complete the preparation of charts which had fallen into arrears. The preliminary work of sorting and arranging all volumes and data for areas in Bengal and Assam was completed. There were 18 triangulation charts in hand of which one has been examined and will be shortly submitted for publication.

67. No. 6 (Simla) Drawing Office.—This office was placed under the Superintendent, Map Publication, from 1st June 1920.

The *Army Section* has dealt with the preparation and printing of maps and plans for the use of the Army and other government departments.

The *Survey Section* has been employed on the preparation of trans-frontier maps on the one millionth, quarter-inch and half-inch scales and incorporating additional information on those previously published.

68. Bengal and Bihār and Orissa Drawing Office.—(Imperial Standard Mapping Section). This section has been employed as usual on the compilation from modern revenue survey material and from other local maps, and on the fair mapping, of the preliminary editions of modern one-inch sheets in colours pending their topographical

revision. The sheets are completed from old material where no modern work is available.

To reduce the labour of drawing on the two-inch scale and the inconvenience of handling the fair map in two sheets all the 16-inch cadastral maps will in future be first of all reduced to the 4-inch scale, detail to be shown will then be inked up and reduced to the 1½-inch scale and all maps fair-drawn on that scale.

Of Bengal 20 new sheets, and of Bihar and Orissa 5 new sheets have been fair-mapped and submitted for publication during the year.

The section has been accommodated in the Head Quarters Offices.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

69. Northern Circle. *No. 1 Party.*—At the request of the Mussoorie City Board, an original survey on the scale of 24 inches = 1 mile was carried out during the year, at a cost of Rs. 9,816. The area surveyed was 2·9 square miles, and the task involved some 45 linear miles of traverse and 36 miles of levelling.

No. 2 Party.—This party completed the survey of Mount Abu and leased area, on the scale of 24 inches = 1 mile commenced in July 1919, the total area surveyed comprising some 5,076 acres, situated on a plateau about 4,000 feet above mean sea level, the highest point, Adhar Devi, being 4,623 feet. The larger portion consists of cultivated and grass lands, but there is a good deal of rocky and intricate ground covered with scrub jungle and trees. The scheduled boundary of the area, which was very considerably in error, was also corrected. The fair-drawing was undertaken immediately the survey was completed and was submitted for publication in April 1920. The cost rate of survey was Rs. 1·5 per acre and of fair-drawing Rs. 0·4 per acre.

Sind-Sāgar Party.—During the year under report, the party was employed on rectangulation of the Sind-Sāgar Doāb in connection with the Punjab Government's Sind-Sāgar Canal and Colonization Project, in Miānwāli, Jhang and Muzaffargarh districts, in continuation of previous seasons.

Sub-division into 100-acre rectangles was carried out over the southern part of the tract, comprising an area of 3549·1 square miles, and embracing parts of Miānwāli, Jhang and Muzaffargarh districts, 22,714 rectangles of 100 acres each were laid out and their corners marked by stones. Practically the whole of the work was tested by the superior revenue staff and the survey staff. The party has now to deal with the sub-division into 100-acre rectangles of the north eastern part of the area, already divided into 120 rectangles of 4,000 acres each. This will be done next field season.

The country under rectangulation lies between the Indus river on the west and the Jhelum and Chénāb rivers on the east and is locally known as the "Thal" (uplands). The tract is a vast rolling desert of sand studded with hillocks covered with stunted vegetation, sparsely populated and almost waterless. There are scattered patches of cultivation irrigated from wells the water of which is generally brackish. The "Thal", with the exception of the central portion which is open, is wooded in parts, a strip of country along its western edge being covered by a dense jungle of trees and high grass. The natural difficulties of the ground tend to impede the work.

In recess the party was employed on completion of the records of the Sind-Sāgar rectangular survey and on preparation of the material for triangulation pamphlets. The purely temporary hands who had been entertained last year were given instruction in traversing, and its computation, in drawing and in typing. In addition to the men above alluded to, 1 soldier surveyor and 8 pupils who were temporarily attached to the party were given training in drawing.

At the request of the Executive Engineer, Thal Survey Division, Miānwāli, 49 published one-inch sheets of the Sind-Sāgar Doāb were marked with 4,000-acre rectangles and corner numbers entered on them.

His further request for 12 sheets of the northernmost area of the Doāb marked with 100-acre rectangles was also complied with.

Four indexes on the scale of 1 inch = 4 miles showing the field work of the last year and this year were prepared and supplied to the Irrigation and Revenue Departments. Two indexes indicating the positions of stone depôts on the same scale were also supplied to them.

In addition a considerable amount of miscellaneous work in connection with the proposed extension of rectangulation in the Lower Bāri Doab was done.

No. 22 (Riverain) Party.—The party continued the work of traversing, and laying down base lines. 371 linear and 429 square miles of main circuits, 2,650 linear and 491 square miles of minor traverses were executed, and 458 theodolite stations of the former, and 11,590 of the latter in 143 villages, were fixed. 798 corners of 266 squares in 883 square miles were demarcated with permanent mark-stones on both banks of the Sutlej and Chenāb rivers in Muzaffargarh, Multān and Montgomery districts and Bahāwalpur State, to serve as bases for the further survey and demarcation of boundaries and fields in the beds of the rivers. 1,554 plotted and 474 boundary *masāvis* on the scale of 1/2,640, and 34 four-inch sheets, and 2 one-inch indexes were traced and supplied to the Settlement Officer, Multān. 15,181 pages of field books and 3,314 of set-up forming 102 volumes were almost completed. Some arrears of computations still remain to be finished. Besides these, 595 boundary *masāvis* were partly compiled on the scale of 220 feet = 1 inch for the next season's work, and 222 miscellaneous traces including 16 traces (scale 4 inches = 1 mile) supplied to the Executive Engineer, Upper Sutlej Division, showing the riverain traverse data along the Sutlej and Chenāb, were prepared; all the traverse stations marked during the year were plotted on 36 four-inch sheets.

The Multān suburbs traversing was begun at the request of the Settlement Officer, Multān, during October 1919, and was finished in February 1920. It was based on the riverain main circuit run along the Chenāb connecting it with Multān Fort, and Multān City Dome. The stations were marked with two bricks placed vertically one above the other. 18 corners of 6 squares were fixed to serve as bases for the future survey. Thirty-three dressed stones were embedded on 15 traverse stations, and on 18 corners of the base lines. 1,114 stations were laid out and 189 linear miles executed in 5 villages covering 20 square miles. 95 plotted *musāvis* on the scale of 55 feet = 1 inch, 184 on the scale of 110 feet = 1 inch and one trace on the scale of 4 inches = 1 mile were supplied to the Settlement Officer, Multān.

The Gujrānwāla town traversing was started at the request of the President Municipal Committee, Gujrānwāla during February 1920, and was finished during April 1920, for the detail survey of the municipal area on the scale of 200 feet = 1 inch. It was connected with Shāhjamāl T. S. XXXVIII, Shāhdara Minaret, and the Chenāb riverain main circuit. The stations outside the congested area were marked with bricks, and inside with 8-inch long iron pegs with round flat tops of 1½-inch radius. In all 617 stations were laid out, 507 for the town survey, and 110 for making the three connections. At the connections the stations were marked with ordinary pegs. 145 linear, and 3 square miles of traversing were done. A trace on the scales of 8 inches and 16 inches = 1 mile showing the stations, and copy of the traverse data were supplied to the President, Municipal Committee, Gujrānwāla.

70. Eastern Circle.—At the request of the Burma Government, a surveyor was deputed to accompany the Deputy Commissioner of the Hill district of Arakan to survey the boundary between Assam and Burma as decided on by the Deputy Commissioners of the Hill districts of Arakan and Lushai Hills, but as no agreement could be reached at the meeting of the two officers, the boundary could not be surveyed. An area of 310 square miles of unadministered area was, however, surveyed on the ¼-inch scale.

No. 11 Party.—At the instance of the Chief of the General Staff the survey, on the scale of 3 inches = 1 mile, with a vertical interval of 25 feet, was made of 103 square miles of country, on the left bank of the Rangoon river, between Syriam and Kyauktan, in the Hanthawaddy district, Burma.

The country surveyed comprises the Kondan ridge, a laterite spur of the Pegu Yoma, extending through the middle of the area from north to south. The western slopes of the ridge descend in undulating ground to the river bank; on the east, from the base of the ridge, is an open expanse of rice fields. The whole area is well inhabited, and, in the vicinity of Syriam, are the important refineries of the Burma Oil Company.

At the request of the Burma Government, a surveyor was deputed to accompany the Assistant Superintendent, North Hsweni State, to point out from existing one-inch maps, and from the report of the Burma-China Boundary Commission of 1898—1900, the position of the boundary line between existing pillars, along a portion of the boundary in the Kokang district, disputed by the Chinese. The disputed boundary and an area of 20 square miles on the British side were resurveyed, and a trace of the map supplied to the political officer, for the settlement of the questions in dispute at the Chief Political Meetings to be held on the frontier in 1920.

71. Head Quarter Offices.—The total out-turn of all extra-departmental publications during the year for the Army, for Local Governments and for other Government offices are given in Table A of the Photo.-Litho. Office report on page 31, in the "Issues" Table and in Table IV of the Map Record and Issue Office report on pages 27 and 28.

In addition to the special maps for other departments which are mentioned in para. 55 (*g*) on page 26, these extra-departmental publications include Royal Artillery Practice Camp maps and various operations and manœuvre maps for the Army, maps to illustrate the Journals of the United Service Institution, various reports of Government officials, &c., and the usual large numbers of weather charts for the Meteorological Department and of the photogravure and half-tone illustrations for the Archæological and other departments.

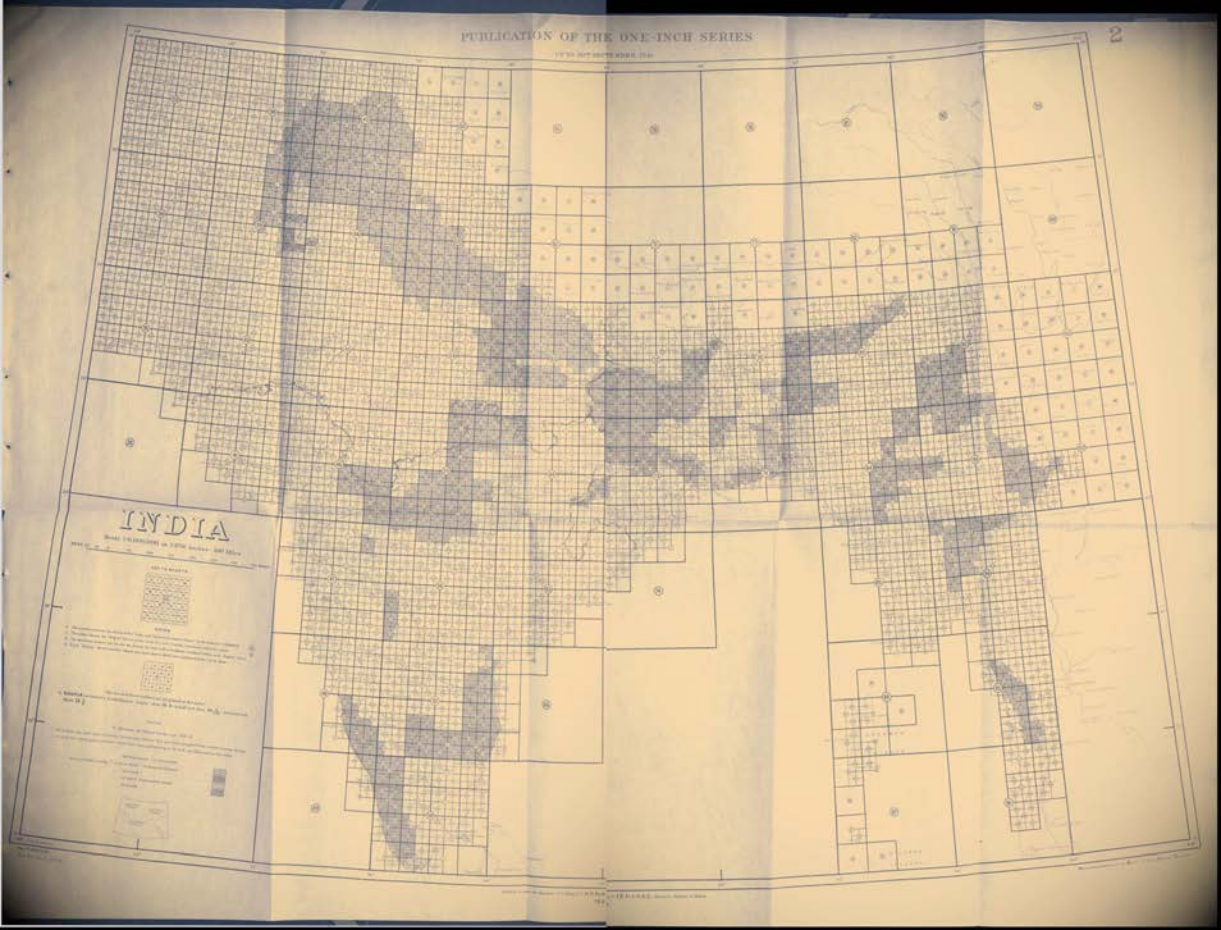
The work entailed by the preparation of originals for some of these special maps, in addition to their publication, is mentioned in the reports of No. 1 Drawing Office and of the Engraving Office on pages 29 to 31.

72. Mathematical Instrument Office.—The manufacture of heliographs, prismatic compasses, scales, protractors, &c., for Military Departments was stopped in the early part of the year, but it has however been taken up again and the large balance on previous orders slowly reduced.

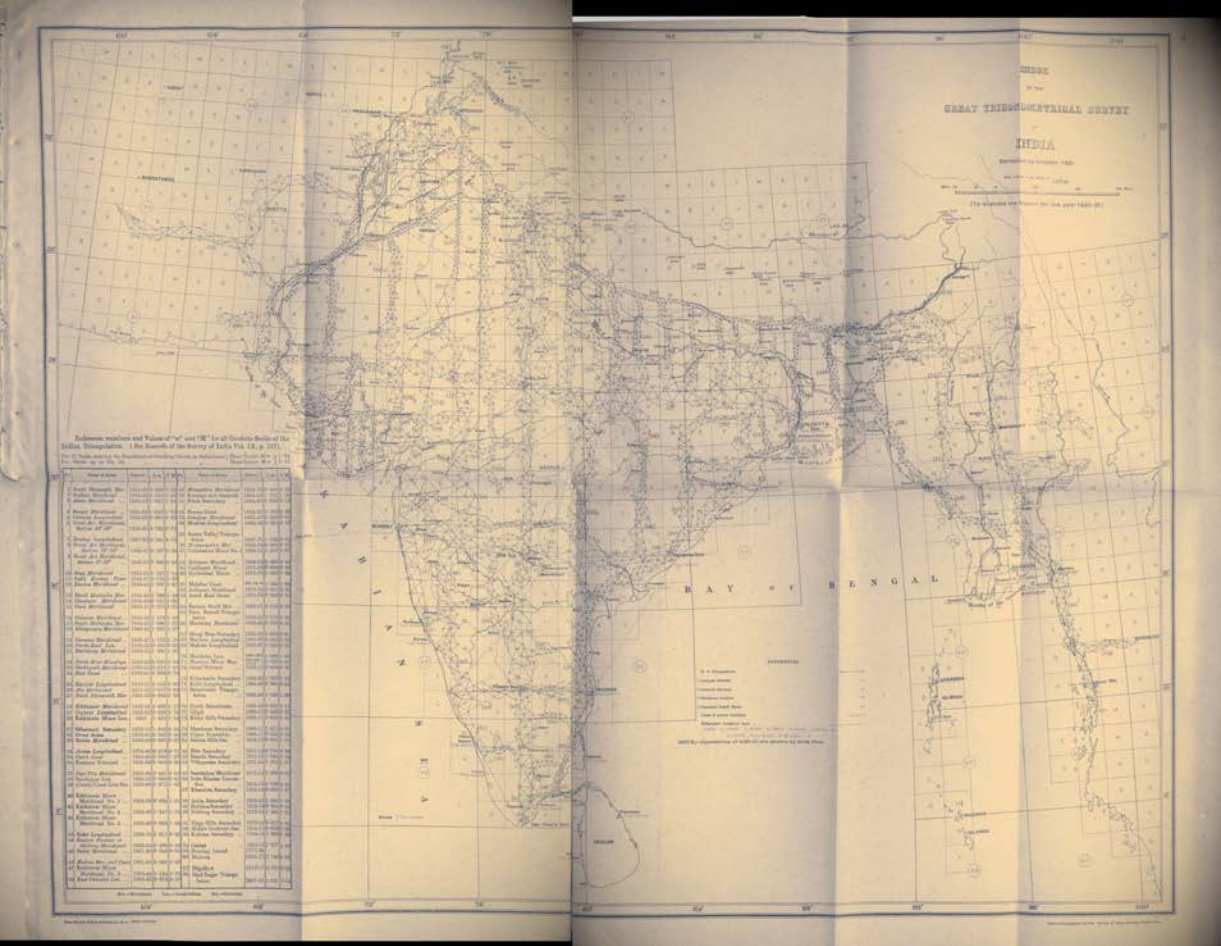
Repair and manufacture for Civil Departments was taken up again and most of the outstanding work for the years 1914, 1915, and 1916 has been completed and that for 1917, 1918 and 1919 is well in hand so that it is hoped to be up to date by end of the cold weather.

Instruments were supplied by this office to many Government offices, Imperial and Provincial.

73. No. 6 (Simla) Drawing Office. In addition to its normal work for the Army the *Army Section* has prepared maps and plans for the Royal Air Force, the Foreign and Political Department, the Commerce and Industry Department and the Journals of the United Service Institution.


INDIA

SURVEY & PUBLICATION.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CEYLON
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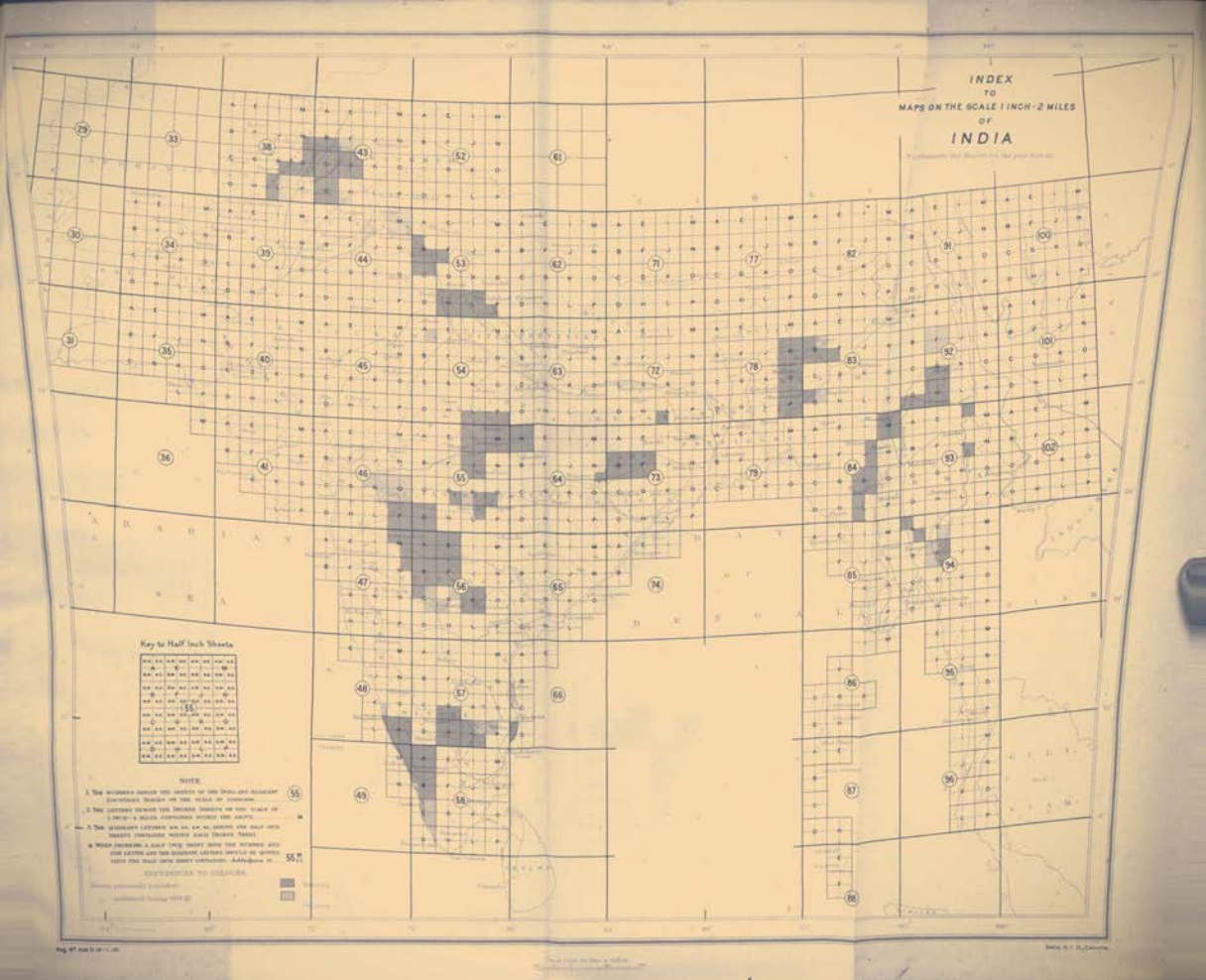
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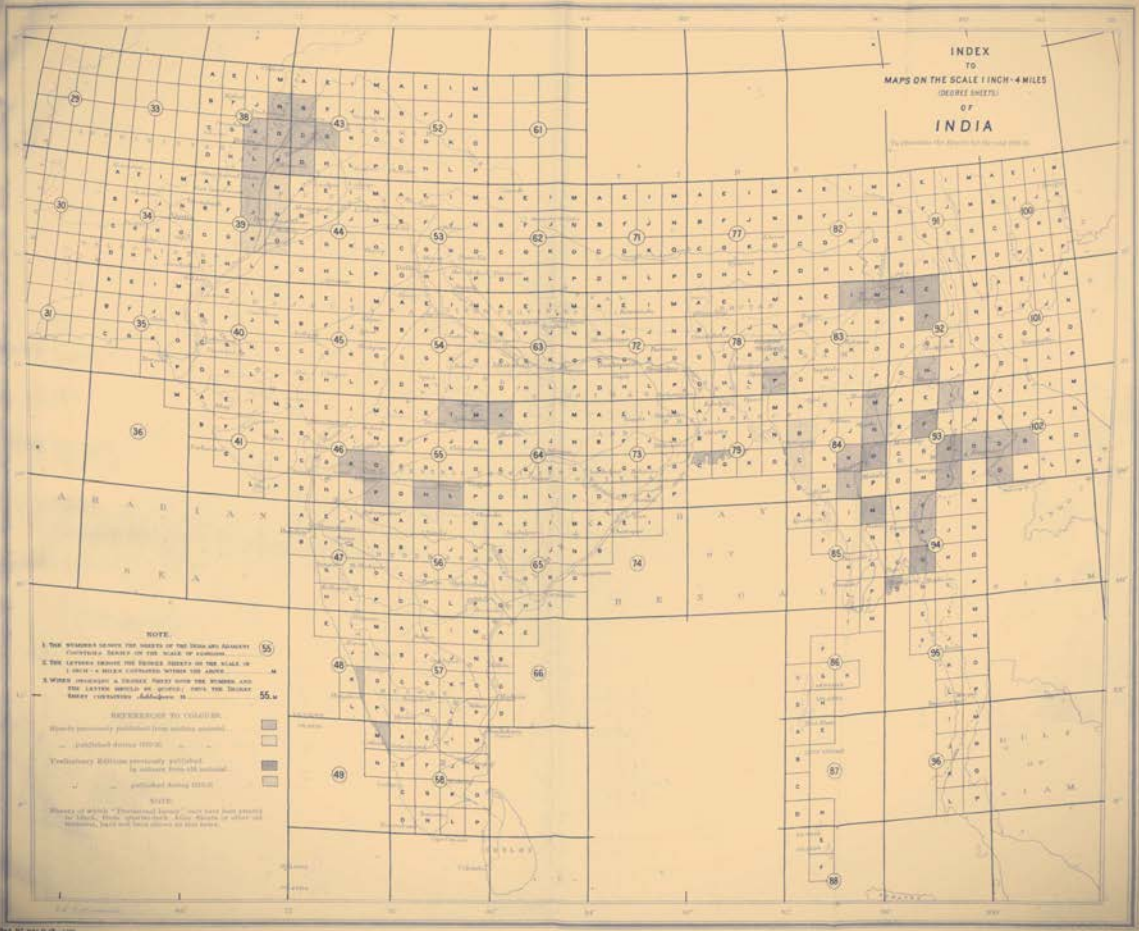
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2. THE LETTERS SHOWN THE TRIANGLES ON THE SCALE OF 1 INCH = 4 MILES CONTAINED WITHIN THE ABOVE.
3. WHERE (AS USUAL) A TRIANGLE FALLS OVER THE NUMBER AND THE LETTER SHOULD BE QUOTED; THUS THE TRIANGLE SHOWN CONTAINED
55.M
REFERENCE TO COLOURS.
Sheets previously published (no outline printed)
published during 1908
Preliminary Edition previously published (a colour from old outline)
published during 1908
NOTE.
Sheets of which "Provisional Issue" only have been issued (in black, blue, sepia-brown, &c.). Areas shown of other old sheets, have not been shown on this index.
ABADIAN
KREA
BEHAR
HILLS
SIAM
LOWER
Tibet
55
48
49
57
58
66
74
85
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87
88
96
36

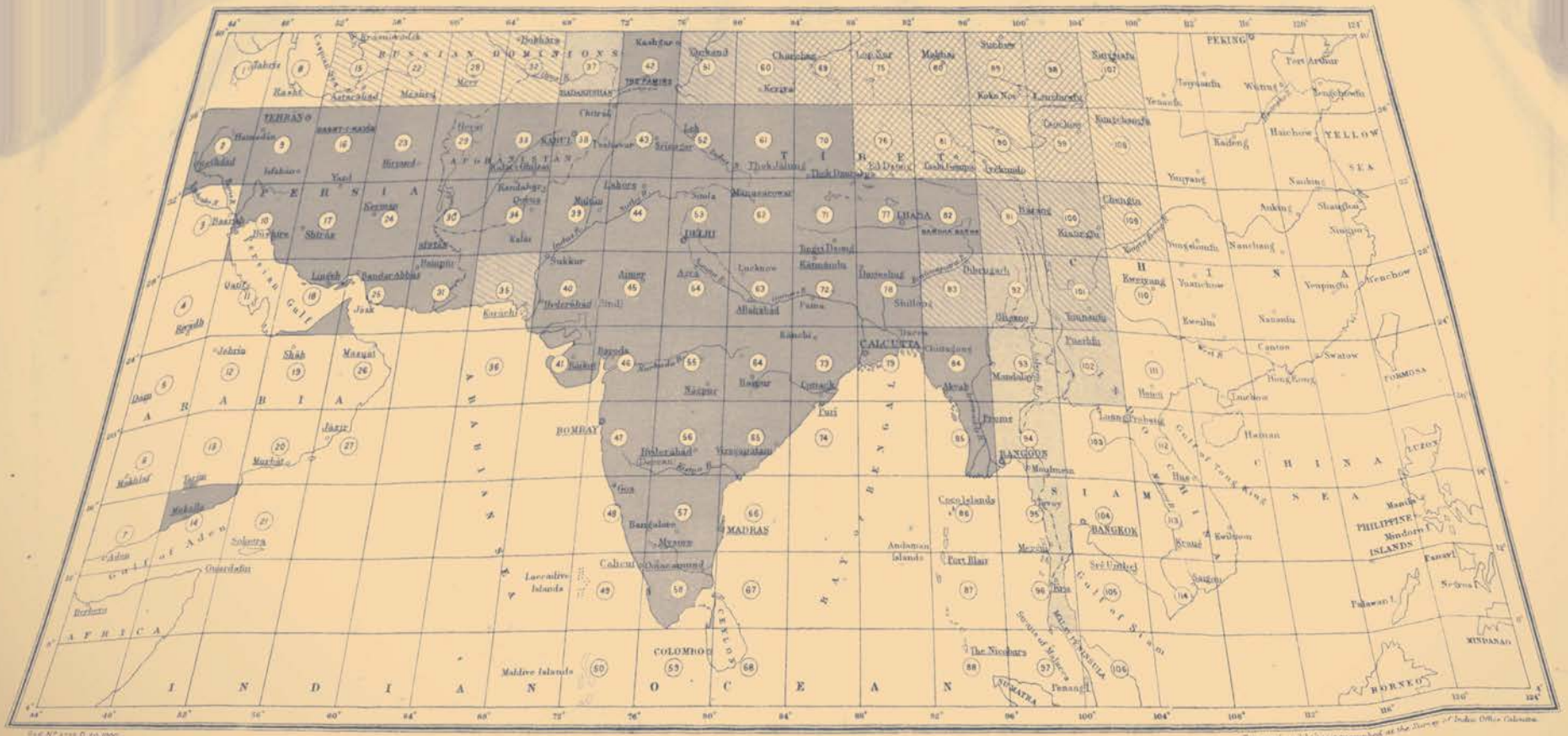
4

DEGREE SHEET SERIES

Scale 1 Inch to 4 Miles.

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000, or 1·014 inches to 16 miles.



Scale 1:1,000,000.

Miles 400 0 200 400 600 800 Miles

NOTE

The names underlined on this Index are the title names of the sheets, and their numbers are shown in circles. Sheets 35 and 36, 57 and 66, are published respectively as combined sheets.

REFERENCE

To illustrate the Report for the year 1913-14

Shewing published outlines of Districts & Talukas

with boundary & towns

under publication

in hand

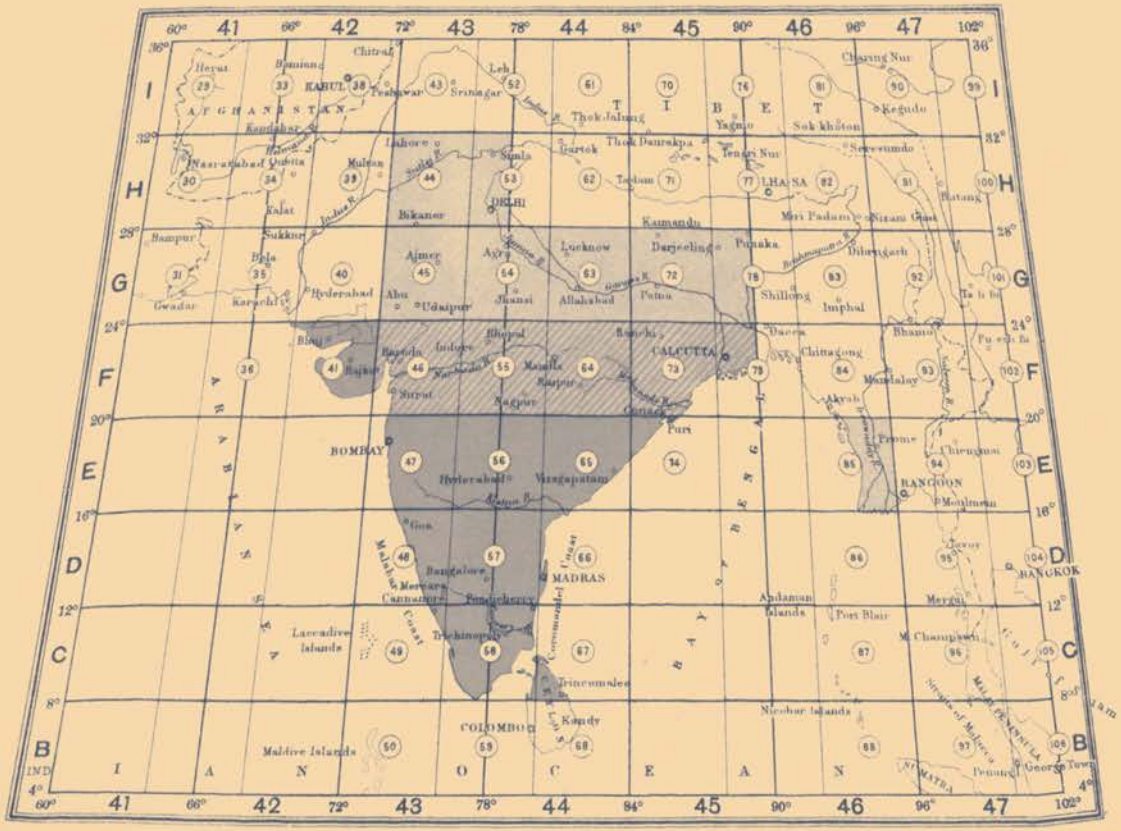
Engraved and hand-coloured at the Survey of India Office, Calcutta.

5

INDIA AND ADJACENT COUNTRIES SERIES

Scale 1:1,000,000.

INDEX TO THE SHEETS OF THE
CARTE INTERNATIONALE DU MONDE
on the Scale of 1:1,000,000.



The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter and number corresponding to its position, *e.g.*, the sheet which includes Bombay is N.E-43

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.

Scale 1:6,000,000.

Miles 200 0 200 400 600 800 Miles

REFERENCE

Sheets published

" under publication

" in hand

To Illustrate the Report for the year 1919-20.

Reg. No. 2441 D., 16.

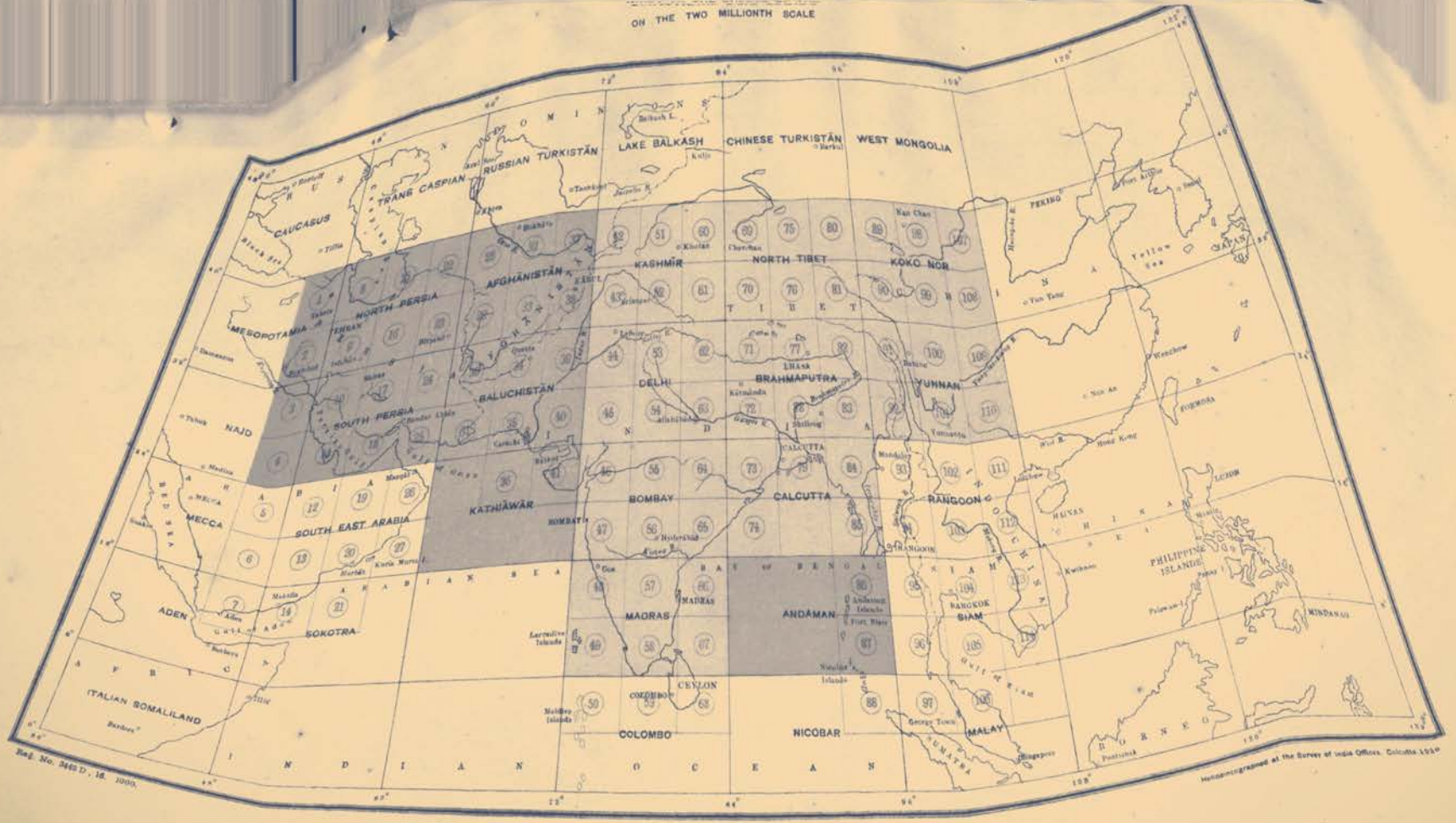
Helio., S. I. O., Calcutta.

6

INTERNATIONAL SERIES

Scale 1:1,000,000.

ON THE TWO MILLIONTH SCALE



Scale 1/40,000,000

Miles 200 0 200 400 600 800 1000 Miles

The E.portions of MESOPOTAMIA and NAJD sheets have been published for the present as outriggers to N.& S.PERSIA sheets respectively.

REFERENCE

To illustrate the Report for the year 1919-20.

Sheets published with contours & layers.

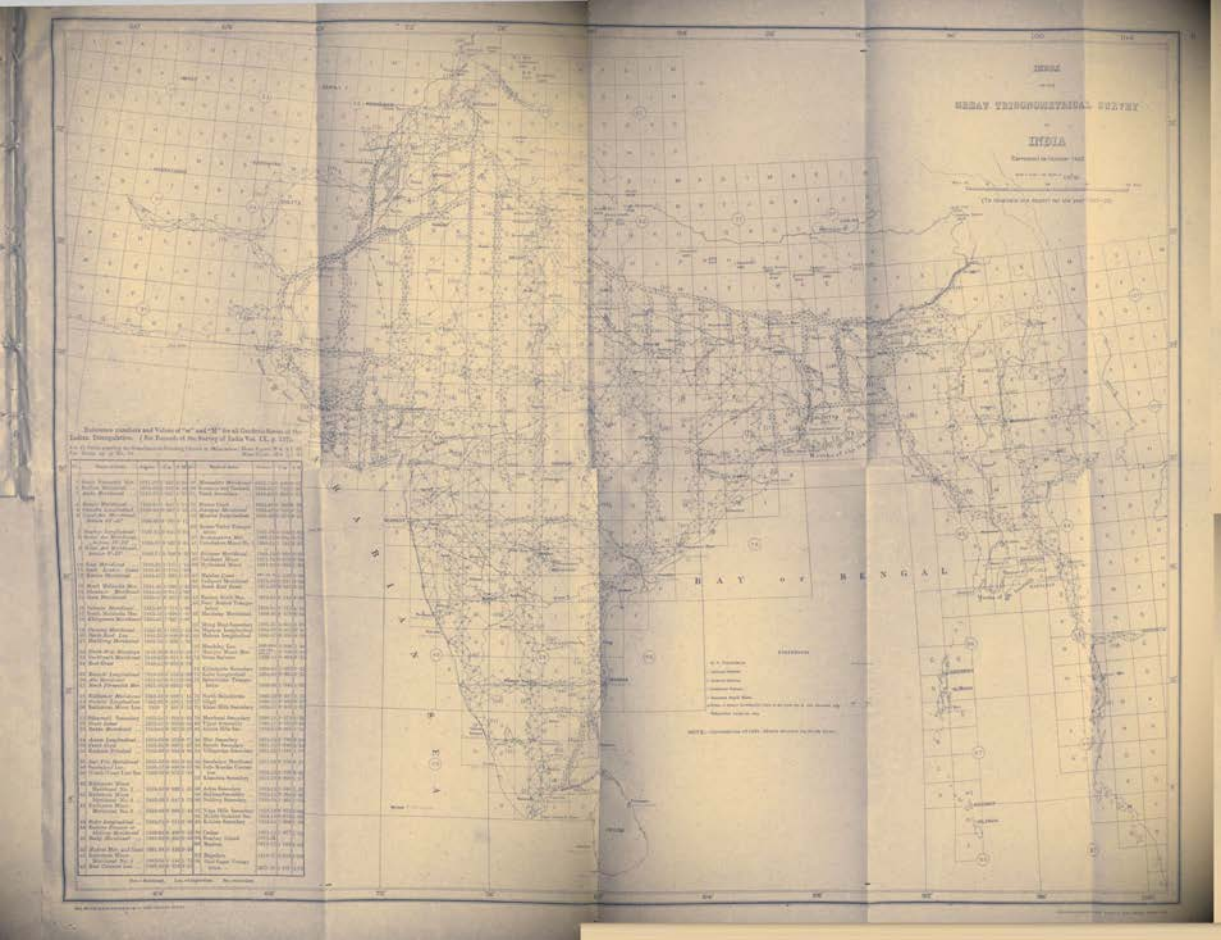
" under publication.

" in hand.

7

SOUTHERN ASIA SERIES

Scale 1:2,000,000.


INDIA
SHOWING
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
BAY of BENGAL

Survey of India.

GENERAL REPORT,

1920–21.

From 1st October 1920.

To 30th September 1921.

PREPARED UNDER THE DIRECTION OF

COLONEL C. H. D. RYDER, C.I.E., D.S.O., R.E.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,

CALCUTTA,

1922.

Printed at the
Photographic and Lithographic Office, Survey of India,
14, Wood Street,
Calcutta.

NOTICE.

MAPS PUBLISHED BY THE SURVEY OF INDIA

are obtainable from the Map Record and Issue Office, 13, Wood Street, Calcutta, on the Public Service—on Cash Payment or Book-Transfer, and, for private use—on Cash Payment or V. P. P.

Forest maps are obtainable only from the Officer in charge, Forest Map Office, Dehra Dún.

Geological maps are obtainable from the Director, Geological Survey of India, Calcutta.

The Survey of India publish maps for the greater part of SOUTHERN ASIA between the meridians of 44° and 124° East of Greenwich and between parallels 4° and 40° north latitude.

2. Surveys executed after 1905 are classed as "MODERN", those PRIOR to that date are classed as "OLD".

3. Maps are printed in two styles or editions viz., LAYERED and POLITICAL:—

(*a*) The LAYERED edition represents a map printed in colours with graduated layer tints of colour to show altitudes, and, shading to emphasize the hills. This edition gives prominence to the physical features.

(*b*) The POLITICAL edition represents a map printed in colours, but without graduated layer tints. Hills are represented by contours and shading. This edition gives prominence to the Civil Divisions of India which are shown by ribands of colour along boundaries of administrative partitions.

NOTE.—When maps are printed in colours, from mixed or old surveys, the edition is styled "PRELIMINARY"; and when published in black only or with hills in brown, the edition is styled "PROVISIONAL" issue.

4. The series of Modern maps are grouped under three Divisions:—

(I) GEOGRAPHICAL, embracing—

(*a*) SOUTHERN ASIA SERIES, scale 1:2,000,000 or nearly 1 inch = 32 miles, in LAYERED and POLITICAL editions, size 36 inches × 24 inches, price Rs. 3 per copy.

(*b*) INDIA AND ADJACENT COUNTRIES; scale 1:1,000,000 or nearly 1 inch = 16 miles, in LAYERED and POLITICAL editions, or if from old surveys, as PRELIMINARY editions; size 24 inches × 19 inches, price Re. 1-8 per copy. If printed on linen-backed paper Rs. 2-4.

(*c*) INTERNATIONAL MAP OF INDIA, scale 1:1,000,000 or nearly 1 inch = 16 miles, in LAYERED edition (without shading of hills), size 30 inches × 26 inches, price Re. 1-0 per copy.

(II) TOPOGRAPHICAL, comprising maps on:—

(*a*) SCALE 1 INCH = 1 MILE, in the POLITICAL edition, size 24 × 19 inches, price Re. 1-8 per copy.

(*b*) SCALE 1 INCH = 2 MILES, in the POLITICAL edition, size 24 × 19 inches, price Re. 1-8 per copy.

(*c*) SCALE 1 INCH = 4 MILES, in the LAYERED and POLITICAL editions, size 24 × 19 inches, price Re. 1-8 per copy, and from old surveys as PROVISIONAL issues, price Re. 1 per copy.

NOTE.—Modern Topographical maps printed on linen-backed paper are Rs. 2-4 per copy. Index charts or Key maps to the Geographical and Topographical series are obtainable gratis.

(III) GENERAL MAPS which include:—

(*a*) GENERAL MAPS OF INDIA, scale 1 inch = 32 miles, in sets of 12 sheets, each sheet 25 × 32 inches, in LAYERED and POLITICAL (without hills) editions, price Rs. 12 per set, and on scale 1 inch = 64 miles, POLITICAL edition only, size about 3½ feet square, at Rs. 6 the copy. Also various maps of India on the same and smaller scales and miscellaneous special maps illustrating Railways, &c.

(*b*) PROVINCIAL MAPS, on scales 1 inch = 16 miles and 1 inch = 32 miles.

(*c*) DISTRICT MAPS, on scales 1 inch = 4 miles and 1 inch = 8 miles.

(*d*) CANTONMENT AND TOWN MAPS AND OTHER MISCELLANEOUS MAPS, of various scales and prices.

5. MAP CATALOGUES can be obtained at ONE RUPEE per copy.

6. Maps can be mounted on cloth and folded or mounted on rollers for hanging, &c., at an extra charge.

7. For particular purposes, copies of any map can be supplied in black or black and brown on request and at special rates.

8. Any map, chart or diagram can be reproduced if the applicant submits a suitable original drawing. Special rates exist for such work and estimates can be given on request.

9. The prices quoted for various maps are exclusive of postage and V. P. P. charges. Any further information may be obtained free of charge from the Officer in charge, Map Record and Issue Office, 13, Wood Street, Calcutta.

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THE CURATOR, GOVERNMENT BOOK DEPÔT, Burma, Rangoon.

THACKER, SPINK & Co., Simla.

COCKBURN AGENCY, Srinagar, Kashmir.

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2. Publication of modern one-inch series.
3. ,, modern half-inch series for India.
4. ,, ,, quarter-inch ,, ,,
5. ,, 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
6. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
7. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
8. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1920—21.

From 1st October 1920
To 30th September 1921.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shown in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XVI of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 39,961* square miles; and that this brings the total progress since 1905 to 580,735 square miles, leaving 1,240,865 square miles still to be done.

3. The first Index map, at the end of the report, shows the progress of this topographical programme both in survey and in publication in the three circles, while the remaining seven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the survey of India is based.

4. Table IV on page 30 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

---

*Excludes 13¼ square miles large scale survey (military) on the eight-inch scale.

6. The following events are notified:—

(*a*) A fairly full programme of topographical work was carried out during the year. The area surveyed being 39,961 square miles compared with 30,464 square miles the previous year. This however does not compare it with the record years before the war, 1912-13 and 1913-14, when 53,377 and 55,786 square miles respectively were surveyed. This is due to the cessation of recruitment of surveyors, &c., during the war, and to the retention of two topographical parties in recess owing to financial stringency. The field work of the Trigonometrical Survey had to be greatly curtailed owing to shortage of officers.

(*b*) The Survey detachment under Major H. T. Morshead, D.S.O., R.E., which was sent with the Mount Everest Expedition returned after completing 12,930 square miles of original survey in Tibet, 3,126 square miles of revision survey in Sikkim and 700 square miles of photo. survey near Mount Everest.

(*c*) Lectures were delivered by Lieut.-Colonel C. P. Gunter, O.B.E., R.E., to the Senior Officers' Class at Belgaum and at Murree, Northern Command, on the subject of survey and mapping, and the use of aerial photography for survey purposes.

(*d*) A competitive examination for admission to the Class II Service was held during the year. 19 candidates sat for examination out of whom 3 were selected.

(*e*) Experimental determinations of longitude by wireless telegraphy were carried out at Dehra Dūn. The Paris "scientific" time-signals were successfully received.

(*f*) The tide predicting machine has been transferred from the National Physical Laboratory at Teddington to Dehra Dūn. The future prediction and publication of tide tables for Indian ports will be carried out by the Survey of India, commencing in 1923.

(*g*) There has been an increased demand on the part of the public for maps during the year.

(*h*) The demand for large scale surveys of towns, &c., is continuous.

(*i*) Most of the personnel employed under the Mesopotamian Administration returned to India by July 1921.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1921 and of the two previous years is shown below:—

	1918-19.	1919-20.	1920-21.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	38,38,091	44,92,352	45,76,608*	* These figures are not final.
Deduct receipts and credits	18,83,964	20,65,422	14,50,650*	
Net actual charges ...	19,54,127	24,26,930	31,25,958*	

8. Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., administered the department from the 17th November 1920 on return from leave. Colonel W. M. Coldstream, R.E., officiated for him during his absence on leave.

9. Of Class I officers:—Colonel Sir Gerald Lenox-Conyngham, Kt., R.E., F.R.S., Lieut.-Colonels C. L. Robertson, C.M.G., R.E., and A. Mears, I.A., and Mr. B. R. Hughes retired, and Captain H. A. Joly deLotbinière, M.C., R.E., reverted to the Home Establishment.

Major F. F. Hunter, D.S.O., I.A., reverted from deputation to Persia and Captain R. S. Wauchope, O.B.E., I.A., from deputation to military duty.

Mr. E. C. J. Bond, V.D., was promoted from the Class II Service.

The following officers were appointed during the year:—

Captains T. M. M. Penney, R.E., H. R. C. Meade, I.A., J. K. Douglas, R.E., R. S. P. MacIvor, I.A., W. J. Norman, M.C., R.E., T. W. R. Haycraft, R.E., and G. W. Gemmell, I.A., Lieutenants G. H. Osmaston, M.C., R.E., H. A. Bazley, R.E., G. F. Heaney, R.E., and G. Bomford, R.E.

The number of officers on deputation to military duty at the end of the year is 1.

Commissary and Honorary Major C. J. Arbery, M.B.E., retired.

Mr. R. C. Malcolm was appointed as Assistant Manager, Mathematical Instrument Office.

Of Class II officers:—Messrs. F. P. Walsh and Syed Zille Hasnain, K.S., retired and Messrs. M. Gastaud and A. Ewing ceased to be re-employed. Mr. H. B. Powell who had been on deputation to Burma died.

Messrs. N. C. Puri, R.S., and E. N. Natesan were promoted from the Upper Subordinate Service.

Captain J. H. Williams reverted from deputation to military duty, and Mr. V. W. Morton, Lieutenant L. B. Fitz-Gibbon and Mr. N. C. Puri, R.S., reverted from deputation under the High Commissioner for Mesopotamia.

Mr. J. O'B. Donaghey was placed on deputation for five months under the Government of Madras.

The number of officers on deputation to military duty at the end of the year is 1.

Mr. J. B. Chorlton was appointed as Assistant Manager, Photo.-Litho. Office.

In the Upper Subordinate Service, Mr. Hamid Gul, K.S., retired, 12 officers were promoted from the Lower Subordinate Service and 14 candidates were appointed on probation, one of whom resigned.

Messrs. Sher Jang, K.B., Annada Prasad Ghosh, Muhammad Hasan and Jagannath reverted from deputation to Mesopotamia.

The total strength of the department at the close of the Survey year was 62* Class I officers, 97† Class II officers and 80‡ Upper Subordinates, besides specialists, clerks, lower subordinates and menials.

10. The following honours were conferred during the year:—

Companion of the Order of the Indian Empire.—	Lieutenant-Colonel H. L. Crosthwait, R.E.
Member of the Order of the British Empire.—	Mr. P. A. T. Kenny, Extra Assistant Superintendent.
Mentioned in despatches.—	Lieutenant-Colonel H. L. Crosthwait, C.I.E., R.E.
	Captain R. S. Wauchope, O.B.E., I.A. (second time).
	Mr. V. W. Morton, Extra Assistant Superintendent.
	Mr. Muhammad Husain Khan, Sub-Assistant Superintendent.
	Surveyor Jalil-ul-Kadr.
	Surveyor Muhammad Ayub Khan.
	Surveyor A. Francis.
	Draftsman Ananta Krishna Ray.
Elected a founder Fellow of the Institute of Physics.—	Dr. J. deGraaff Hunter, Sc.D., M.A.
Khan Sahib.—	Mr. Muhammad Husain Khan, Sub-Assistant Superintendent.

Mr. J. C. St. C. Pollett, Extra Assistant Superintendent, has been granted a commission as 2nd-Lieutenant in the 6th Bangalore, Coorg and Mysore Battalion, Auxiliary Force, India.

11. The following table shows the distribution of officers during the year. The names of officers on leave, on deputation to Local Governments, on military duty or on foreign service throughout the year are omitted; the names of some of the officers on leave, military duty or on foreign service during the greater part of the year are also omitted.

* Including one officer on temporary military duty.

† Including one officer on temporary military duty, officers on foreign service and probationers but excluding officers re-employed and on deputation to Local Governments (except Mr. P. Simpson on deputation to Bihar and Orissa).

‡ Including probationers and one officer on foreign service.

TABLE I—DISPOSITION OF OFFICERS, 1920-21.

SURVEYOR GENERAL OF INDIA— Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E. (on leave up to 16th November 1920). Colonel W. M. Coldstream, R.E., Officiating to 16th November 1920.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Major H. J. Couchman, D.S.O., M.C., R.E.			

SUPERINTENDENT, MAP PUBLICATION— Lieut.-Colonel G. A. Beazeley, D.S.O., R.E.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud (re-employed). ,, J. Prasad, R.S.		
No. 1 Drawing Office, Map Record and Issue Office, & Engraving Office, Calcutta.	Major F. F. Hunter, D.S.O., I.A. ,, C. M. Thompson, I.A.	,, P. Williams ,, J. Prasad, R.S. ,, Pramadaranjan Ray, R.S. ,, Abinash Chunder Bose ,, C. West ,, Asmat-ullah Khan, K.B. ,, A. B. Hunter ,, Priya Nath Sur ,, F. B. Kitchen ,, Munshi Lal, B.A. ,, H. H. P. Butterfield ,, Jiya Lal Sahgal		
Photo.-Litho. Office, Calcutta.	Lt.-Colonel A. A. McHarg, D.S.O., R.E. Major A. H. Gwyn, I.A.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier, C.B.E. (re-joined from leave on 7th September 1921.) ,, S. Woodhouse (*Offg.*).			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).		Mr. C. West	Mr. Charu Chandra Biswas	
No. 6 Drawing Office (Simla).	Major L. G. Crosthwait, I.A.	Mr. R. E. M. Sanbolle ,, A. J. A. Drake, D.C.M. ,, H. H. P. Butterfield	Mr. Sher Jang, K.B.	5 European Draftsmen. 4 Printers. 2 Clerks. 15 Indian Draftsmen. 7 Pupil Draftsmen.

SUPERINTENDENT, NORTHERN CIRCLE { Lieut.-Colonel H. L. Crosthwait, C.I.E., R.E., up to 13th December 1920. Lieut.-Colonel H. Wood, R.E., from 14th December 1920.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.	Mr. J. A. Freeman	Mr. A. A. Graham ,, Moqimuddin ,, H. G. Shaw (re-employed).		41 Surveyors, &c.
No. 1 Party, *North-West Frontier Province, Punjab and United Provinces.*	Major H. T. Morshead, D.S.O., R.E.	Mr. P. A. T. Kenny, M.B.E. Major C. H. Tresham Mr. R. C. Hanson ,, A. J. A. Drake, D.C.M. ,, H. T. Hughes	Mr. Jamna Prasad, R.S. ,, Muhammad Husain Khan, K.S. ,, Vidya Dhar Chopra ,, Afraz Gul Khan ,, Muhammad Khan ,, Jit Singh Rawat ,, Sijawal Khan	44 Surveyors, &c.
No. 2 Party, *Central India, Delhi Province, Rājputāna and United Provinces.*	Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E.	Mr. C. O. Picard ,, Dani Chand Puri ,, Prafulla Kumar Ghosh, B.Sc. (*on probation*). ,, T. O. Threlfall (*on probation*).	Mr. Muhammad Husain ,, Imam Din ,, Lakshmi Dutt Joshi ,, Daulat Ram Vohra ,, Narsingh Das Joshi (*on probation*).	48 Surveyors, &c.
No. 3 Party, *United Provinces.*	Bt.-Major C. G. Lewis, R.E. Captain L. H. Jackson, I.A. ,, E. A. Glennie, D.S.O., R.E. (*on probation*).	Mr. E. B. West ,, L. Williams ,, J. H. Johnson ,, G. E. R. Cooper	Mr. Laltan Khan, I.D.S.M.	44 Surveyors, &c.
No. 4 Party, *United Provinces.*	Mr. J. A. Freeman ,, H. H. B. Hanby ,, M. C. Potters Captain L. H. Jackson, I.A.			18 Surveyors, &c.
Sind-Sāgar Party, *Punjab.*	Major R. Foster, I.A.	Mr. Dhani Ram Verma ,, J. C. C. Lears ,, Maya Das Puri, R.S. ,, D. N. Banerjee, L.C.E.	Mr. Chuni Lal Kapur ,, Nabidad Khan ,, Amrit Ram	10 Surveyors, &c. 27 Local Revenue staff.
No. 22 (Riverain) Party, *Punjab.*	Mr. H. H. B. Hanby	Mr. Dhani Ram Verma ,, Maya Das Puri, R.S. ,, Abdul Karim, B.A.	Mr. Jamna Prasad, R.S. ,, Ram Narayan Hastir ,, Vidya Dhar Chopra ,, Gulab Singh	48 Surveyors, &c.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1920-21.

SUPERINTENDENT, SOUTHERN CIRCLE — Lieut.-Colonel C. P. Gunter, O.B.E., R.E., up to 19th October 1920. Brevet-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., from 20th October 1920 to 31st January 1921. Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 1st February to 15th March 1921. Lieut.-Colonel H. H. Turner, R.E., from 16th March 1921.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.	Mr. J. H. Nichol ,, J. O'B. Donaghey		Mr. B. V. Narayana Rao ,, Damodar Khadilkar	40 Draftsmen, &c.
No. 5 Party, *Berár, Bombay, Central India and Central Provinces.*	Major L. C. Thuillier, I.A. Captain G. Lennox, I.A. *(on probation).*	Mr. F. C. Pilcher ,, F. W. Smith ,, Muhammad Najam-uddin, B.A. *(on probation).*	Mr. P. S. Vengusvami ,, J. A. Cabral *(on probation).*	32 Surveyors, &c.
No. 6 Party, *Bangalore.*	Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Mr. J. O'B. Donaghey	Mr. H. B. Simons ,, E. A. Meyer ,, Munshi Lal, B.A. ,, N. S. Harihara Iyer ,, E. N. Natesan, B.A.	Mr. K. G. Mandanna	25 Surveyors, &c.
No. 7 Party, *Madras.*	Major J. D. Campbell, D.S.O., R.E.	Mr. F. R. Grant ,, A. F. Murphy ,, N. S. Harihara Iyer ,, E. N. Natesan, B.A.	Mr. K. Narayanasvami Chetti ,, Damodar Khadilkar ,, Shib Lal ,, Shadi Lal Dube	34 Surveyors, &c.
No. 8 Party, *Madras and Travancore State.*	Lieut.-Colonel M. O'C. Tandy, D.S.O., O.B.E., R.E.	Mr. C. E. C. French ,, M. Mahadeva Mudaliar, M.A. ,, B. T. Wyatt ,, M. S. Ganesa Aiyar ,, J. C. St. C. Pollett ,, J. A. Calvert	Mr. H. Narasimhamurti Rao ,, Shaikh Muhammad Salik ,, Abdul Ghafur	49 Surveyors, &c.
No. 20 Party, *Cantonment and Military District Lands in the 9th Division.*	Mr. B. R. Hughes Captain J. K. Douglas, R.E. *(on probation).*	Mr. J. H. S. Wilson	Mr. Dharmu ,, J. M. Mukerji	31 Surveyors, &c.
Training Section	Lieut.-Colonel C. P. Gunter, O.B.E., R.E.	Mr. S. S. McA'F. Fielding ,, V. W. Morton ,, F. R. Grant	14 Probationers	23 Surveyors and Pupils.
Record Section		Mr. Haji Abdul Rahim, K.B.	Mr. Annada Prasad Ghosh	9 Computers, &c.

SUPERINTENDENT, EASTERN CIRCLE — Lieut.-Colonel E. T. Rich, C.I.E., R.E., up to 22nd November 1920. Colonel W. M. Coldstream, R.E., from 23rd November 1920.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.	Mr. W. M. Gorman ,, M. C. Petters	Mr. E. Claudius Lieut. C. S. McInnes Captain J. O'C. Fitzpatrick	Mr. Jagdeesh Prasad Vastav ,, Bansi Ram	25 Surveyors, &c.
No. 9 Party, *Bengal and Bihár and Orissa.*	Bt.-Lieut.-Colonel R. H. Phillimore, D.S.O., R.E.	Mr. E. J. Biggin ,, E. G. Hardinge ,, Amar Krishna Mitra Lieut. C. S. McInnes Mr. Bhupendra Nath Saha, M. SC. *(on probation).*	Mr. Jagdeesh Prasad Vastav ,, Amulya Charan Ghosh ,, Gopal Lal Mitra ,, Samadhar Mukerjee *(on probation).*	29 Surveyors, &c.
No. 10 Party, *Upper Burma.*	Lieut.-Colonel E. T. Rich, C.I.E., R.E. Captain O. Slater, M.C., R.E. *(on probation).*	Mr. W. G. Jarbo ,, G. E. R. Cooper ,, H. H. Creed ,, H. M. Critchell *(on probation).*	Mr. Hayat Muhammad, K.S. ,, Dhirendra Nath Saha ,, Ram Prasad, K.S. Maung Pe, A.T.M.	15 Surveyors, &c.
No. 11 Party, *Lower Burma.*	Mr. J. O. Greiff Captain T. M. M. Penney, R.E. *(on probation).*	Mr. O. J. H. Hart ,, F. C. Saint ,, F. J. Grice ,, A. V. Dickson	Mr. Pratul Chandra Sen Gupta, B. SC. ,, Khan Muhammad	31 Surveyors, &c.
No. 12 Party, *Assam.*	Bt.-Lieut.-Col. C. M. Browne, C.M.G., D.S.O., R.E. Major F. B. Scott, I.A.	Mr. E. M. Kenny ,, D. K. Rennick, M.B.E. ,, Prafulla Chandra Mitra, B.A.	Mr. Girija Sonker Bagchi	31 Surveyors, &c.
No. 21 (Burma Forest) Party, *Upper and Lower Burma.*	Mr. H. W. Biggin	Mr. S. F. Norman Lieut. L. B. Fitz-Gibbon Captain V. P. Wainright ,, C. B. Sexton Mr. H. M. Critchell *(on probation).*	Mr. Dalbir Rai ,, Ghulam Hasan ,, Bhamba Ram	14 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1920-21.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY — Major R. H. Thomas, D.S.O., R.E., up to 16th November 1920. Lieut.-Colonel H. L. Crosthwait, C.I.E., R.E., from 17th November 1920 to 13th March 1921. Lieut.-Colonel H. McC. Cowie, R.E., from 14th March 1921.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	Major H. T. Morshead, D.S.O., R.E. ,, F. J. M. King, R.E. (*On probation*). Captain T. M. M. Penney, R.E. ,, H. R. C. Meade, I.A. ,, J. K. Douglas, R.E. ,, R. S. P. MacIvor, I.A. Lieut. G. H. Osmaston, M.C., R.E. ,, H. A. Bazley, R.E. Captain W. J. Norman, M.C., R.E. Lieut. G. F. Heaney, R.E. Captain T. W. R. Haycraft, R.E. Lieut. G. Bomford, R.E. Captain G. W. Gemmell, I.A.	Mr. G. J. S. Rae ,, Nanak Chand Puri, B.A., R.S.	Mr. Lalbir Singh	
Computing Office.	Dr. J. deGraaff Hunter, M.A., SC.D., F. Inst. P.	Mr. Hanuman Prasad	Mr. Sarat Kumar Mukerji	49 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dún.	Major F. J. M. King, R.E. Captain R. S. P. MacIvor, I.A. (*on probation*).	Mr. G. J. S. Rae ,, H. P. D. Morton ,, Rama Prasad Ray, B.A. ,, T. F. Kitchen ,, F. B. Kitchen ,, O. D. Jackson	Mr. Ram Singh, R.S. ,, Paras Ram ,, Jugal Behari Lal ,, Baldeo Bihari Lal ,, Sadik Ali ,, Muhammad Hasan ,, Kunja Behari Lal	162 Draftsmen, &c.
No. 13 Party, (*Astronomical*).	Captain H. E. Roome, M.C., R.E. ,, G. Lennox, I.A. (*on probation*).			1 Computer, &c.
No. 14 Party, (*Pendulum*).	Lieut.-Colonel H. McC. Cowie, R.E. Captain R. S. Wauchope, O.B.E., I.A. ,, E. A. Glennie, D.S.O., R.E. (*on probation*). ,, H. R. C. Meade, I.A. (*on probation*).			1 Clerk, &c.
No. 15 Party, (*Triangulation*).	Bt.-Major K. Mason, M.C., R.E. ,, ,, E. O. Wheeler, M.C., R.E. (*on probation*). Captain O. Slater, M.C., R.E. (*on probation*).			7 Computers, &c.
No. 16 Party, (*Tidal*).	Mr. O. C. Ollenbach	Mr. Hanuman Prasad ,, Syed Zille Hasnain, K.S. ,, D. H. Luxa		20 Computers, &c.
No. 17 Party, (*Levelling*).	Bt.-Major K. Mason, M.C., R.E.	Mr. O. N. Pushong ,, Raj Bahadur Mathur, B.A. ,, K. S. Gopalachari, B.A. ,, Narendra Nath Chuckerbutty, L.C.E.	Mr. Karuna Kumar Das, B.A. ,, Satish Chandra Mukerjee ,, Pulin Behari Roy ,, A. A. S. Matlub Ahmad	15 Computers, &c.
No. 18 Party, (*Magnetic*).	Mr. E. C. J. Bond, V.D.	Mr. Nikunjo Ronjon Mazumdar.	Mr. Bidhu Bhusan Shome ,, Hem Chandra Banerjee, B.A.	1 Magnetic Observer. 10 Computers, &c.
No. 19 Party, (*Base Line*).	Major C. M. Thompson, I.A.			2 Clerks, &c.

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

12. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905 and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shown in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 569,800 square miles are likely to be surveyed on the half-inch or smaller scales.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
1917-18 ...	ditto ...	4,202	12,181	8,396	24,779
1918-19 ...	ditto ...	509	7,263	6,176	13,948
1919-20 ...	ditto ...	9,145	11,891	9,428	30,464
1920-21 ...	ditto ...	14,411*	14,275	11,275	39,961
Total areas completed to date ...		235,866	188,596	156,273	580,735
Approximate areas for the whole topographical programme.		750,000	542,800	528,800	1,821,600
Approximate areas remaining for survey.		514,134	354,204	372,527	1,240,865

* Excludes 13¾ square miles large scale military survey on the scale of 8 inches = 1 mile.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1920-21.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
NORTHERN CIRCLE.						
No. 1 Party—*North-West Frontier Province, Punjab and United Provinces.*						
Wooded hills	Quarter-inch Revision Survey...	159	8,400	1,78,147	21·2	
Ditto	Half-inch Revision Survey ...	2,865				
Ditto	Half-inch Original Survey ...	465				
Ditto	One-inch Revision Survey ...	5,052				
Ditto	One-inch Original Survey ...	359				
Plain, partly cultivated and partly waste land.	Large-Scale Survey ...	13½	13½	6,028	446·5	
No. 2 Party—*Central India, Delhi Province, Rājputāna and United Provinces.*						
Cultivated plains, open with occasional isolated low rocky hills.	Half-inch Original Survey ...	1,059	4,094	87,245 (a)	21·3	(a) Excludes Rs. 7,933 debitable to Allahābād Improvement Trust, Rs. 12,764 cost of half-inch mapping and Rs. 46,175 cost of training pupils and soldier surveyors.
Cultivated plains, open ...	One-inch Resurvey ...	1,693				
Ditto ditto ...	One-inch Revision Survey ...	1,208				
Low rocky hills and cultivated plains.	Four-inch Revision Survey ...	134				
No. 3 Party—*United Provinces.*						
Densely wooded hills and plains ...	One-inch Revision Survey ...	610	1,917	1,53,408 (b)	80·0	(b) Excludes cost of traverse which was rejected.
Densely wooded hills	One-inch Original Survey ...	60				
Wooded hills	Two-inch Original Survey ...	1,247				
TOTALS, NORTHERN CIRCLE:— 14,424½ sq. m.				Rs. 4,24,828	Cost-rate 29·4	
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**SOUTHERN CIRCLE.**
No. 5 Party—*Berār, Bombay, Central India and Central Provinces.*						
Intricate jungle-clad hills and well wooded plains.	One-inch Original Survey ...	2,768	3,871	1,13,130	29·2	
	One-inch Revision Survey ...	1,103				
No. 6 Party—*Bangalore*		...	...	...	...	Did not take the field.
No. 7 Party—*Madras.*						
Open, undulating country ...	One-inch Original Survey ...	3,383	5,243	1,20,993 (c)	24·2 (d)	(c) Excludes cost of half-inch mapping and arrears of triangulation computations.
Hilly jungle-clad ,, ...	Two-inch Original Survey ...	628				
Ditto ,, ...	One inch Supplementary Survey	440				
Ditto ,, ...	Two-inch Supplementary Survey	65				
Open, undulating and jungle-clad hills.	One-inch Revision Survey ...	727				(d) As only 4,330 square miles of fair-mapping has been done in the party, this rate has been obtained after adding a proportionate amount for the remaining 913 square miles surveyed.
No. 8 Party—*Madras and Travancore State.*						
Flat coastal plains and high hills	One-inch Original Survey ...	303	5,161	1,89,547 (e)	36·7	(e) Includes cost of computations and fair-mapping.
	One-inch Supplementary Survey	4,810				
	Two-inch Original Survey ...	43				
	Two-inch Supplementary Survey	5				
TOTALS, SOUTHERN CIRCLE:— 14,275 sq. m.				Rs. 4,23,670	Cost-rate 29·7	

Table III.—(Concluded).—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1920-21.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
EASTERN CIRCLE.						
No. 9 Party—*Bengal and Bihār and Orissa.*						
Flat and cultivated plains, in parts congested with villages, in parts cut up by tidal creeks and forests.	One-inch Original Survey ...	2,115	3,000	1,71,068 (*f*)	57·0	(*f*) Excludes Rs. 16,142 for instruction of pupils.
Open undulating plains varied with rocky scrub covered hills.	One-inch Supplementary Survey	703				
Flat plains congested with well wooded villages and factories.	One and a half-inch Revision Survey.	182				
No. 10 Party—*Upper Burma.*						
Densely wooded hills and plains ...	Half-inch Original Survey ...	3,843	3,843	2,32,417	60·5	
No. 11 Party—*Lower Burma.*						
Intricate hills and low ground with mangrove swamp and densely wooded.	One-inch Original Survey ...	1,494	1,494	2,27,805 (*g*)	152·5	(*g*) Includes cost of Maymyo Drawing office and excludes Rs. 30,144 on account of cost of Forest boundary traverse and triangulation in connection therewith.
No. 12 Party—*Assam.*						
Hills mostly covered with forest and high grass, valleys densely wooded.	Half-inch Original Survey ...	2,633	2,766	1,64,089	59·3	
Hills and plains densely wooded ...	Two-inch Original Survey ...	133				
No. 21 (Burma Forest) Party—*Upper Burma.*						
Wooded hills	Two-inch Original Survey ...	103	172	1,39,533	811·2	
Ditto	Four-inch Original Survey ...	69				
TOTALS, EASTERN CIRCLE:— 11,275 sq. m. Rs. 9,34,912					Cost-rate	82·9
GRAND TOTALS:— 39,974½ sq. m. Rs. 17,83,410					Cost-rate	44·6

NORTHERN CIRCLE (*vide* Index map No. 1).

13. No. 1 Party.—This party surveyed an area of 8,400 square miles, chiefly revision survey on the one-inch and half-inch scales, and original survey on the one-inch and half-inch scales, in the Kāngra and Simla districts, Chamba, Mandī, Suket and Simla Hill States of the Punjab. The party also completed a large scale military survey of a small area in the Kohāt district of the North-West Frontier Province for a proposed cantonment.

Triangulation in advance was carried out in the Tehrī-Garhwāl State of the United Provinces.

The country surveyed and triangulated lay entirely in the Himālayas and ranged from 950 feet to over 22,000 feet in altitude. Part of this was surveyed during the summer.

14. No. 2 Party.—This party surveyed an area of 4,094 square miles as follows:— 897 square miles in Bharatpur State, 124 square miles in Alwar State and 1 square mile in Jaipur State, all of the Rājputāna Agency, as also 37 square miles in the Muttra district of the United Provinces, on the half-inch scale; 61 square miles in Bharatpur State and 2,840 square miles in the Agra, Muttra, Alīgarh, Etah, Mainpurī and Budaun districts of the United Provinces on the one-inch scale and 134 square miles on the four-inch scale in Imperial Delhi and Vicinity (*vide* page 20).

The country surveyed on the one-inch scale consisted of open cultivated plains, except in a few places where trees were numerous, while that surveyed on the half-inch scale also consisted of open cultivated plains but included occasional isolated low rocky hills.

Traversing was also carried out in the Gwalior and Dholpur States and in Allahābād City (*vide* page 46).

15. No. 3 Party.—This party surveyed an area of 1,247 square miles on the two-inch scale and 670 square miles on the one-inch scale in Garhwāl, Almorā, and Nainī Tāl districts of the United Provinces and in the Indian state of Garhwāl-Tehrī and in Nepāl, triangulated an area of 1,280 square miles in Garhwāl and Almorā districts and in Nepāl, and traversed 44·2 linear miles in Nepāl. The survey of the Kumaun hills is being executed chiefly in the interests of the Forest Department (*vide* page 17). The maps will be published on the two-inch scale.

16. No. 4 Party.—This party continued in abeyance until September 1921, when preparations for taking the field were commenced.

17. Training.—22 pupil surveyors were entertained and given instruction in drawing during recess. 10 of these were discharged as unlikely to become good surveyors, 6 will take the field for training in survey, while 6 will remain in the circle office for further training in drawing. Of the pupil surveyors entertained in 1919 and 1920, 17 were promoted unclassified surveyors, 6 were discharged, and the remainder have been distributed for further training during the coming field season.

In addition 13 soldier surveyors are undergoing their first period and 7 their second period of training.

18. Recess Work.—The progress in the fair-mapping of the current season's sheets was retarded owing to the arrears remaining over from the previous year, and to the fact that No. 1 Party had a summer field season this year. It is hoped to complete all arrears by the end of next recess.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1921 :—

Sheets on the one-inch scale ...	... 26
Sheets on the two-inch scale ...	... 16
Sheets on the half-inch scale ...	... 3
Town-guide maps ...	... 5

Of these, 12 will be submitted for publication before the end of October.

19. Records Section.—Triangulation data for 10 degree sheets were compiled. All triangulation and traverse records were re-indexed, and a report prepared showing all triangulation and traverse work in the Northern Circle area, executed prior to 1905, falling in sheets which have not been surveyed on the modern system.

20. Particulars of special work done by Nos. 2, 22 and Sind-Sāgar Parties will be found on pages 20, 46 and 47.

SOUTHERN CIRCLE (*vide* Index map No. 1).

21. No. 5 Party.—This party surveyed an area of 3,871 square miles on the one-inch scale in the north-east portion of the East Khāndesh district of Bombay, the Amraotī and Buldāna districts of Berār, the Indore State of Central India and the Makrai State and Nimār district of the Central Provinces. It also triangulated an area of 2,199 square miles in the Bhopāwar Agency, the Amjhera and Ujjain districts of Gwalior State. the States of Dewās and Indore of Central India and the north-west corner of the Nimār district of the Central Provinces. The country consists of jungle-clad hills, well wooded cultivated plains and the elevated plateau around the city of Indore.

22. No. 6 Party.—The head-quarters of the party remained at Bangalore throughout the year and completed the fair-mapping of 4,602 square miles, on various scales, of Būshire and Shīrāz in Persia, Secunderābād, Bolārum, and the Mahbūbnagar district of Hyderābād (Deccan), Kolār district of Mysore and Anantapur district of Madras.

An area of 670 square miles in the Mahbūbnagar district of Hyderābād (Deccan) was triangulated with supplementary points for the forward season's topography.

23. No. 7 Party.—This party surveyed an area of 5,243 square miles on different scales in the Guntūr, Nellore, Kurnool, Cuddapah and Anantapur districts of Madras and the Kolār and Tumkūr districts of Mysore.

The country surveyed is partly flat, open and cultivated and partly hilly and jungle-clad.

24. No. 8 Party.—This party surveyed an area of 5,161 square miles on the two-inch and one-inch scales in Rāmnād, Madura, Tanjore and Coimbatore districts of Madras and Travancore State. The area surveyed consisted chiefly of flat coastal plains irrigated by numerous tanks, but also included a portion of the Palni hills and high hills in Travancore State rising to a height of 8,841 feet at Anaimudi, the highest hill in Southern India.

25. The report on the survey of cantonments and military stations undertaken by No. 20 Party appears on page 20. See also page 47, para. 69.

26. Training Section.—The three probationers of the Upper Subordinate Service who remained under instruction from the previous year completed their course on the 31st October 1920 and were then transferred to parties. The new class of Upper Subordinates consisting of 14 probationers joined on 3rd January 1921 and were put through a short course of plane-tabling, triangulation, traversing and levelling. One probationer was allowed to resign on 3rd June 1921. Eight will be transferred to parties so as to join at the commencement of the 1921-22 field season, and the remaining five will continue training for a few months longer.

21 pupil surveyors were under training at the commencement of the year; of these 4 were discharged during the year as being unlikely to make efficient surveyors. 7 pupils were transferred to parties during the year, the remaining 10 were retained till the end of the year for further instruction.

22 new pupil surveyors were recruited between August 1920 and May 1921. During recess they have received preliminary training in drawing and plane-tabling.

27. Recess Work.—27 one-inch sheets out of 50 surveyed during the year under report were received in the circle office up to the 30th September 1921. All the remaining sheets will be fair-mapped before the close of the recess season.

There was no original half-inch survey carried out during the year.

There are no arrears of drawing from previous season's work.

28. Record Section.—This section was formed on 1st May for the purpose of dealing with triangulation and traverse data of the circle and preparing the triangulation pamphlets and charts. Nine pamphlets and charts were prepared and submitted for publication during the year.

EASTERN CIRCLE (*vide* Index map No. 1).

29. No. 9 Party.—This party surveyed an area of 3,000 square miles on the scales of 1½ inches and 1 inch=1 mile in the neighbourhood of Calcutta and in Bihār. Work fell in the Hooghly, Midnapore and Twenty-four Parganas districts of Bengal and the Monghyr district of Bihār.

South of Calcutta, work covered the reclaimed area of the Sundarbans in the Twenty-four Parganas district, and progress was much interfered with by tidal creeks and forests. Drinking water was bad, and the health of surveyors suffered considerably.

In Monghyr district the one-inch preliminary sheets prepared from recent cadastral surveys were found very accurate, and the supplementary survey carried out amounted to little more than the survey of the more hilly parts and the contouring of the remainder.

A large number of pupils were trained by the party during the year.

30. No. 10 Party.—This party surveyed an area of 3,843 square miles on the half-inch scale in the Putao district, in the unadministered territory of the Hukawng valley adjoining the Myitkyinā district of Upper Burma and in the tribal territory, locally known as "The Triangle", between the Mali Hka and N'mai Hka branches of the Irrawaddy. It also triangulated 3,594 square miles in advance for topographical surveys on the half-inch scale, in unadministered territory adjoining the Myitkyinā and Upper Chindwin districts. The area surveyed in the Putao district

consisted of a broken mass of hills covered with dense jungle, extending from the N'mai Hka at an altitude of 2,000 feet to the Irrawaddy-Salween divide, at an average altitude of 12,000 feet, with peaks rising to nearly 14,000 feet. Almost the whole area in the Hukawng valley was covered with dense jungle and comprised a level plain crossed by numerous big streams and bounded on the north and east by high hill ranges rising in places to 11,000 feet.

31. No. 11 Party.—Survey operations were continued in Lower Burma, in the Mergui district. 1,494 square miles were surveyed on the one-inch scale and 2,012 square miles triangulated in advance for detail survey, 355 of which consisted of revision of last season's work and connection with Siamese triangulation.

The party also carried out the traversing of the boundaries of five reserved forests in the Amherst district, 275 linear miles being traversed and 1,297 square miles of triangulation being carried out in this area.

The country surveyed in the Mergui district comprised the source and upper waters of the Ngawun, the upper reaches of the Lenya river, portion of the boundary between Burma and Siam, and some coastal areas near Bokpyin. The inland area consists of dense impenetrable jungle covering deep valleys and intricate hills, rising to a height of over 3,000 feet, and the coastal areas are mangrove swamp cut up by numerous tidal creeks.

32. No. 12 Party.—This party surveyed an area of 2,766 square miles on the two-inch and half-inch scales in the districts of Nowgong, Cāchār and Khāsi and Jaintiā Hills. An area of 2,752 square miles of triangulation and 326 linear miles of traversing (covering an area of 248 square miles) was carried out in the districts of Nowgong, Sibsāgar, Nāgā Hills, Cāchār and Manipur State, in advance of detail survey.

The area surveyed in Nowgong was flat country, partly cultivated and partly covered with high grass and trees. The remaining districts consisted of partly open but mostly densely wooded hills rising to about 5,600 feet.

33. No. 21 (Burma Forest) Party.—The work done by this party is included in that shown in Forest Surveys, Eastern Circle, page 19. See also page 48, para. 72.

The area over which operations extended is hilly, ranging in altitude from 200 to 5,000 feet and covered with dense forest growth.

34. Training.—This was carried out by No. 9 Party and in the Maymyo Survey School. In addition to 1 Class II and 2 Upper Subordinate officers and 3 soldier surveyors, 6 second year and 19 first year pupils accompanied No. 9 Party to the field and 14 new pupils were entertained at the beginning of the recess season. The average out-turn of the pupils was encouraging. During the year 4 pupils were discharged and 2 soldier surveyors and 8 pupils have been drafted to parties.

At Maymyo 52 pupils, mostly Burmans, were at different times under training. Of these, 24 were discharged or resigned, after varying periods of instruction, 10 have been drafted to parties and 18 retained for further training. It is early yet to judge whether recruiting in Burma will give good results. The pupils of the Maymyo school will be employed next field season on the actual survey of Kalaw forest and of a portion of Maymyo.

35. Recess Work.—The sheets which had to be drawn by the parties of the Eastern Circle during the recess season numbered 59, including 16 'forest' sheets and 18 sheets which were in arrears from last year. By the 30th of September, 9 of the arrears sheets and 7 of the sheets surveyed

during the year were received in the Eastern Circle office. The great majority of the remainder will be despatched from parties by the close of the recess season on October 31st and special arrangements have been made to complete the mapping of the others before next recess season.

36. Record Section.—A small section for the preparation of triangulation data and charts for publication in the triangulation pamphlets was formed early in the year. It prepared 10 pamphlets and charts before it was disbanded, at the beginning of the recess season, owing to the staff being required for other work.

II.—FOREST SURVEYS.

37. Details of the topographical surveys of reserved forests executed by field parties of the Survey of India for the year under report are given below. In the majority of cases the surveys were carried out on the two-inch scale, but in special cases the four-inch and one-inch scales were used. Boundary surveys were made where required, and plots prepared on the four-inch scale.

NORTHERN CIRCLE.

38. United Provinces. Kumaun Forest Circle.—In the *North Garhwāl Forest Division*, 8 square miles of reserved forests were surveyed on the two-inch scale, and an area of 260 square miles (including non-forest areas) was triangulated in advance for future surveys on the two-inch scale.

In the *South Garhwāl Forest Division*, 170 square miles of reserved forests were surveyed on the two-inch scale.

In the *Central Almorā Forest Division*, 37 square miles of reserved forests were surveyed on the two-inch scale. There are four-inch uncontoured maps of 14 square miles of this area. In addition an area of 180 square miles (including non-forest areas) was triangulated in advance for future surveys on the two-inch scale.

In the *East Almorā Forest Division*, 187 square miles of reserved forests were surveyed on the two-inch and 22 square miles on the one-inch scale. There are four-inch uncontoured maps of the latter area. In addition an area of 840 square miles (including non-forest areas) was triangulated in advance for future surveys on the two-inch scale.

In the *Rānīkhet Forest Division*, 64 square miles of reserved forests were surveyed on the two-inch scale.

SOUTHERN CIRCLE.

39. Madras. II Forest Circle.—In the *Guntūr Forest Division*, areas of 562·50 and 34·68 square miles of the reserved forests were surveyed on the two-inch and one-inch scales respectively as follows:—

Name.			Area in square miles.
Andugulapādu	R. F.	...	3·06
Koppukonda	,,	...	13·01
Nāyanipālem	,,	...	2·19
Bollāpalli	,,	...	94·51
Guttikonda	,,	...	73·60
Jānapādu	,,	...	5·20
Sītārāmpuram	,,	...	1·54
Konanki	,,	...	7·95
Nemalipuri	,,	...	16·46
Mādinapādu	,,	...	17·71
Tangeda	,,	...	4·87
Regulagadda	,,	...	5·07
Vemavaram	,,	...	3·21
Govindapuram	,,	...	6·04
Venkatūyapālem	,, (part)	...	9·44
Pillutla	,,	...	4·20
Goli	,,	...	8·86
Tumurkota	,,	...	11·53
Pasvemula	,,	...	35·09
Kandlagunta	,,	...	78·82
Ganglagunta	,,	...	31·33
Mutukūru	,,	...	87·00
Kakirala	,,	...	33·59
Daida	,,	...	4·96
Gāmālapādu	,,	...	2·10
Dāchepalle	,,	...	1·16
		Total ...	562·50
Vinukonda	R. F.	...	12·32
Muppālla	,,	...	4·24
Kopparam	,,	...	1·00
Kūkutlapalle	,,	...	0·04
Mandādi 1	,,	...	3·16
Mandādi 2	,,	...	1·68
Veludurti	,,	...	5·68
Pāluvāyi	,,	...	1·08
Mādugala	,,	...	3·56
Dārvemula	,,	...	1·92
		Total ...	34·68

III Forest Circle.—In the *Nellore Forest Division*, areas of 72·38 and 29·54 square miles of the reserved forests were surveyed on the two-inch and one-inch scales respectively as follows:—

Name.			Area in square miles.
Nandanavanam	R. F. Block A. Extn. A & A, 1	...	23·83
Ditto	Block B. ...	... ...	24·97
Vedullacheruvu	R. F.	... ...	11·88
Hājīpuram	,,	... ...	3·13
Kanigiri Hill	,,	... ...	3·18
Musunūru	,,	... ...	1·62
Peda Cherlāpalli	,, (part)	... ...	1·20
Peda Alavalapādu	,,	... ...	2·57
		Total ...	72·38

Name.				Area in square miles.
Veligonda	R. F.	...	...	15·76
Dasaripalli	,,	...	...	1·22
Rāviguntapalli	,,	...	...	2·16
Inimerla	,, (part)	...	...	6·48
Guvvadi	,, (,,)	...	...	1·04
Totalacheruvupalli	,, (,,)	...	...	2·88
		Total	...	29·54

V Forest Circle.—In the *Madura Forest Division*, an area of 48·628 square miles comprising the "Ampthill Downs" Reserve was surveyed on the two-inch scale.

EASTERN CIRCLE.

40. Assam. Western Forest Circle.—In the *Cāchār Forest Division*, 68 square miles of Krungming and Langting Mupā Forest Reserves were surveyed on the two-inch scale. In the *Khāsi and Jaintiā Hills Forest Division*, 48 square miles of Saipung Forest Reserve were surveyed on the two-inch scale.

Eastern Forest Circle.—In the *Nowgong Forest Division*, 17 square miles of the Rangkhang, Hojāi and Habaipur Forest Reserves were surveyed on the two-inch scale.

187 linear miles of traversing was carried out in the reserves above mentioned, of which 100 linear miles followed no well-defined natural feature.

41. Burma. Delta Forest Circle.—In the *Bassein Forest Division*, 405 square miles of triangulation and 186·3 linear miles of traversing, covering an area of 245 square miles were carried out in the Podaw, Kyeintali, Sitsayan, Shwemyindin, Kungyaung and Kyetpaung Reserves. In the two last reserves the completion of the traverse work had to be postponed because of *khedda* operations.

Tenasserim Forest Circle.—In the *Ataran Forest Division*, the boundaries of the following reserves were traversed:—Dali Reserve and Extensions, Kyaikkamaw Reserve and Extensions, Tagundaing Reserve, Kyonkawun and Moulmein Fuel Reserves. The total linear distance traversed was 274·60 miles and the approximate area covered by these reserves is 327 square miles.

In the *South Tenasserim Forest Division*, 190 square miles of the Ngawun Reserve Forest were surveyed in the course of the ordinary topographical surveys on the one-inch scale.

Northern Forest Circle.—In the *Mansi Forest Division*, an area of 68·8 square miles was surveyed on the four-inch scale including the whole of Hwelit and parts of Mode and Chaunggyibya Reserves.

Southern Forest Circle.—In the *Meiktila and Southern Shan States Forest Divisions*, areas of 45·1 and 58·2 square miles respectively were surveyed on the two-inch scale of the following reserves:—Yupadaung, Wetpyuye Ye-E and Magwe. A small portion of the Magwe Reserve was surveyed last year.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

42. No. 2 Party.—A section of this party carried out the third biennial revision on the four-inch scale of the four sheets of Delhi and Vicinity including 58 square miles in Imperial Delhi and Delhi New Cantonment and 76 square miles in the vicinity, outside Imperial limits. Only very minor changes were disclosed other than those due to building operations.

The cost-rate of the revision is Rs. 45·1 per square mile and that of the fair-maps, which will be submitted for publication early in November 1921, Rs. 15·0 per square mile.

43. No. 20 Party.—During the year under report the party completed the survey of the following cantonments and military lands on the sixteen-inch scale:—

Wellington, Wellington Sanitary area, Wellington Catchment area, Aravanghāt (Aruvankadu) Cordite Factory grounds, Kārteri Cordite Factory grounds, water supply channel from Bairani stream to the Cordite Factory boundary, drinking water supply channel from Dodabetta to Cordite Factory boundary, High Tension line from Kārteri to Aravanghāt (Aruvankadu), Kaity rest camp, Lovedale Estate and extension for Lawrence Memorial School, ground on which military buildings are erected at Ootacamund, Cannanore, West Hill (Calicut) and Velichi military lands.

The surveys of the following bāzārs on the sixty-four-inch scale were also completed:—St. Thomas's Mount, Poonamallee, Pallāvaram and Cannanore.

The surveys of the Bangalore Civil and Military Station on the sixteen-inch scale and of the General, Shūle, Halsūr bāzārs and Arab lines, Bangalore, on the scale of one inch = fifty feet are in progress and almost completed.

The traversing and triangulation of Deolāli for a sixteen-inch survey has been completed.

The levelling of 50·9 linear miles was undertaken in cantonments on which to base traverse heights, at a cost of Rs. 83·9 per linear mile.

The fair-mapping of the following cantonments and military lands have been completed during the year:—Secunderābād Cantonment and bāzār, Pallāvaram Cantonment and bāzār.

87 sheets have been fair-mapped and submitted to press, 61 more sheets have been completed and 83 remain to be completed.

The out-turn on the sixteen-inch scale, of original survey, was 9,111 acres and revision survey, was 5,583 acres. On the sixty-four-inch scale the out-turn of original survey was 283·5 acres. In addition 489·4 acres of original survey have been carried out on the one-inch = fifty feet scale.

The cost-rate of original detail survey on the sixteen-inch scale was Rs. 1·1 per acre and the average daily out-turn per surveyor 14·7 acres, the cost-rate of revision survey on this scale was Rs. 1·8 per acre and the daily out-turn per surveyor 12·4 acres.

The cost-rate of original survey on the sixty-four-inch scale was Rs. 7·0 per acre and the average daily out-turn per surveyor was 1·7 acres.

The cost-rate of original survey on the one inch = fifty feet scale was Rs. 28·3 per acre and the average daily out-turn per surveyor 0·55 acre.

The cost-rate of triangulation for all scales of survey was Re. 0·3 per acre.

The cost-rate of traversing for all scales was Rs. 76·0 per linear mile, the average number of stations being 9 per linear mile.

The total area fair-mapped was 23,714 acres on the sixteen-inch scale, 236 acres on the sixty-four-inch scale and 238 acres on the one inch = fifty feet scale.

The cost-rate of fair-mapping on the sixteen-inch, sixty-four-inch and one inch = fifty feet scales was Re. 0·6, Rs. 15·1 and Rs. 39·2 respectively per acre.

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scales of 16 and 64 inches = 1 mile, up to the end of 1920-21.

(1)	Agar	Cantonment.	(23)	Jullundur	Cantonment.
(2)	Aurangābād	do.	(24)	Kālka	do.
(3)	Bakloh	do.	(25)	Kamptee	do. and Bāzār.
(4)	Balūn or Thath (Dalhousie)	Camp area.	(26)	Landour	do.
(5)	Bannu	Cantonment.	(27)	Meerut	do. and Bāzār.
(6)	Chaman	do.	(28)	Nasīrābād	do. do.
(7)	Chitrāl	Station.	(29)	Nīmach	do. do.
(8)	Dehra Dūn	Cantonment.	(30)	Peshāwar	do. do.
(9)	Deoli	do.	(31)	Quetta	do.
(10)	Drazinda	Out Post.	(32)	Quetta	Fort.
(11)	Drosh	Cantonment.	(33)	Quetta	Civil Station.
(12)	Delhi New	do.	(34)	Rājkot	Cantonment.
(13)	Erinpura	do.	(35)	Rāwalpindi	do.
(14)	Fort Lockhart.		(36)	Sahāranpur	Remount Depôt.
(15)	Ghairat	Station.	(37)	Sanāwar	Cantonment.
(16)	Guna	Cantonment.	(38)	Saugor	do.
(17)	Hangu	do.	(39)	Siālkot	do.
(18)	Hāpur (Bābūgarh)	Remount Depôt.	(40)	Simla	Indian Infantry Lines.
(19)	Hosūr	do.	(41)	Sītābaldī	Fort (Nāgpur).
(20)	Jandola	Out Post.	(42)	Thal	Cantonment.
(21)	Jatta	do.	(43)	Topa	do.
(22)	Jhelum	Cantonment.	(44)	Zām	Out Post.

IV.—THE TRIGONOMETRICAL SURVEY.

GEODETIC OPERATIONS.

44. No. 13 Party.—Astronomical, No. 14 Party.—Pendulum, No. 15 Party.—Triangulation, and No. 19 Party.—Base Line Operations.—No field operations were carried out by these four parties, the personnel being employed at the Headquarters offices of the Trigonometrical Survey, or on special duty.

45. No. 16 Party.—Tidal Operations.—Tidal registrations were carried out by means of self-registering tide-gauges during the year under report at the following stations:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1. Aden	1879 ...	Still working	42	
2. Karāchi	1868 ...	1880	*13 } 53	*With a small tide-gauge.
	1881 ...	Still working	40 }	
3. Bombay (Apollo Bandar)	1878 ...	,,	43	
4. Bombay (Prince's Dock)	1888 ...	,,	33	
5. Madras	1880 ...	1890	10 } 36	
	Restarted 1895	Still working	26 }	
6. Kidderpore ...	1881 ...	,,	40	
7. Rangoon ...	1880 ...	,,	41	
8. Moulmein ...	1880 ...	1886	6 } 18	
	Restarted 1909	Still working	12 }	
9. Port Blair ...	1880 ...	,,	41	

In addition to the above, the actual times and heights of high and low water at Bhaunagar, Chittagong and Akyab, were observed on watches and tide-poles under the orders of the Port Officers concerned, who forwarded these results monthly to this office.

Hourly readings of the height of the water, read against a tide-pole, were taken at Basrah throughout the day and night, and were supplied to this office weekly by the Director, Inland Water Transport, Mesopotamia. The observations for the year commencing 1st January 1920 were reduced by harmonic analysis, and the constants thus deduced were used in the computations of data for the Basrah tide-tables for 1922.

These data were forwarded to the Director, National Physical Laboratory, Teddington, England on the 6th January 1921, and were used for the preparation of the 1922 tide-tables with the aid of the tide-predicting machine.

The tide-tables for 1922 for Basrah were received on the 26th and 29th September 1921, and have already been despatched to the port officials requiring them.

The tide-tables for 1922 for the Indian ports have not been received as yet, but intimation was received of their having been despatched from England on the 12th August 1921. They are expected to be received in India shortly, and will be distributed to the various port officials as soon as possible after their receipt.

Tidal registrations at the nine observatories still working have been carried out satisfactorily, and will be continued during the coming year. During the past year these observatories were all inspected.

46. The following table shows the annual and decadal percentages of errors in the predicted times and heights of high and low water at the 9 stations where observations have been taken by self-registering tide-gauges :—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

Year.	AT OPEN COAST STATIONS.					AT RIVERAIN STATIONS.				
	Number of Stations.	IN TIME.		IN HEIGHT.		Number of Stations.	IN TIME.		IN HEIGHT.	
		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{10}$ of mean range at springs.		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{10}$ of mean range at springs.
		H.W.—L.W.		H.W.—L.W.	H.W.—L.W.		H.W.—L.W.		H.W.—L.W.	H.W.—L.W.
1911	6	84	84	98 99	97 98	3	65	51	68 66	90 90
1912	6	82	82	97 98	97 98	4	70	58	74 62	94 91
1913	6	83	82	97 97	98 99	4	68	55	70 58	94 88
1914	6	77	79	96 97	98 98	3	75	67	71 55	92 84
1915	6	82	82	98 98	96 96	3	76	66	73 67	94 92
1916	6	81	82	96 97	96 99	3	81	68	73 62	93 87
1917	6	75	72	96 98	96 97	3	78	65	69 64	92 88
1918	6	83	82	97 97	97 96	3	76	63	66 65	90 89
1919	6	78	75	96 97	97 98	3	74	65	70 69	93 92
1920	6	82	81	94 97	97 98	3	76	66	64 62	89 86
Average of ten years	...	81	80	97 98	97 98	...	74	62	70 63	92 89

47. *Tide-predicting machine.*—This machine, which has been used for the prediction of the tides of India and the adjacent coasts since 1879, was originally erected at the observatory of the India Stores Department, London, under the control of Mr. Edward Roberts. In 1905 the instrument was transferred to the control of the Director, National Physical Laboratory, Teddington, England, under whose direction the prediction of tides for Indian ports has been completed up to the end of 1922. In 1920 it was decided that the future prediction and publication of the tide-tables for Indian ports should be carried out in India by the Survey of India, who would commence the prediction of tides for 1923. The tide-predicting machine was accordingly despatched from England, and was received in Dehra Dūn towards the end of September 1921. On being unpacked it was found to have been badly damaged in transit. Arrangements are being made to have the machine repaired, and as soon as this is completed the machine will be erected and the prediction of tides for 1923 will be commenced.

48. No. 17 Party.—Levelling.—Four double and one special detachments were employed during the past season on the levelling operations summarised below :—

(*a*) *In Bengal and Bihār*, for Nadiā Rivers Scheme.

(*i*) From Tinpahār to Jiāganj.

(*ii*) From Chākdaha to Berhampore.

(*iii*) From Berhampore to Jayrāmpur.

(*iv*) From Berhampore to Jiāganj.

(*v*) From Porādaha *viâ* Nator to Rautāra.

(*b*) *In Bihār*, for Irrigation Department.

From Darbhangā to Bagahā by the B. B. and C. I. Railway.

(*c*) *In the United Provinces*, for the Sārdā Canal Project.

(*i*) From Pilībhīt to Mailānī.

(*ii*) From Shāhjahānpur *viâ* Mailānī, Kherī-Lakhīmpur to Sītāpur.

(*iii*) From Sītāpur to Lucknow with a branch line to Mādhoganj.

(*iv*) From Lucknow *viâ* Rāe Barelī and Sultānpur to Fyzābād.

(*v*) From Sultānpur to Allahābād.

(*vi*) From Shāhjahānpur to Baghauli.

(*d*) *In the United Provinces.* Revision work due to loss of old bench-marks since 1867-68.

From Bareilly to Pilībhīt.

(*e*) *In Bombay and Baluchistān*, for the Sukkur Barrage Project.

From Jacobābād *viâ* Sehwān to Hyderābād.

This line was levelled on the system for high precision work and forms part of line 101 of the new level net of India.

(*f*) *In the United Provinces and Rājputāna*, for the new level net of India. (Line 107).

From Muttra to Mārwār Pāli.

(*g*) *In the City and environs of Lahore.* Tertiary levelling for the city sanitation scheme.

The total out-turn consisted of 685 miles of primary levelling, 1,314 miles of secondary levelling and about 75 miles of tertiary levelling.

Of this, 1,725 miles of levelling, mainly secondary, were executed at the request of Local Governments, Irrigation departments, &c.

The heights of 55 primary, 1,636 secondary and 259 tertiary bench-marks were determined.

A new hand-book on Levelling of Precision was published during the year.

MAGNETIC SURVEY.

49. No. 18 Party.—Magnetic.—The declination, horizontal force and vertical force magnetographs continued in operation throughout the year at the Dehra Dūn and Toungoo observatories, and daily absolute magnetic observations were taken regularly by the observers in charge. The observatories were visited during the field season and observations consisting of declination, horizontal force and dip were taken for the comparison of instruments. The Kodaikānal and Alībāg observatories, under the control of the Meteorological Department, were also visited by the officer in charge of the magnetic survey for the same purpose.

Observations at Repeat Stations.—Six repeat stations at even distances apart, most of them *en route* to the observatories, were selected and observed at this field season. The stations will be visited annually to take magnetic observations with the object of ascertaining in what year, during the interval of the 5-yearly observations at all repeat stations, an appreciable change in the curve of secular change is indicated, so that it may be possible to determine with greater accuracy the rate of annual change which the magnetic elements undergo in different parts of India.

Reduction of observations to epoch.—The reduction of the observations at the field and repeat stations in India, which was last year reported to be under revision, is now well in hand and will be completed about the end of the year.

Great magnetic storm.—A magnetic storm of great intensity, which seriously interrupted the working of the telegraphs in India, was recorded at the observatories from the 13th to the 17th May 1921. The magnitude of the storm was greater, and its duration three times longer, than the big storms of the 11th and 12th August 1919 and 22nd March 1920.

The Magnetic elements at observatories.—The computation and tabulation of the provisional values of dip, declination, horizontal force and vertical force for the three observatories Dehra Dūn, Toungoo, and Kodaikānal, for the year 1920, have been completed: the mean values of these elements derived from all days, excluding those of great disturbances, are given in the table below:—

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1920.

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 59·9	E 1 52·0	·32951	·32949
Toungoo ...	18 55 45 N 96 27 3 E	N 23 7·7	W 0 23·7	·39114	·16707
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 36·1	W 1 49·9	·37787	·03042

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

50. Brief reports of the work carried out during the year under review in the six offices administered by the Map Publication Office are given in paras. 52 to 56, 64, 65 and 76.

Work under war conditions having ceased, requisitions by the Army for maps, &c., have resumed normal proportions.

51. The classes of maps for the publication of which the Head Quarter Offices are responsible are as follows:—

(*a*) Topographical maps on the one-inch scale.
(*b*) Topographical maps on the half-inch scale.
(*c*) Topographical maps on the quarter-inch scale.
(*d*) (*i*) Geographical maps on the 1:1,000,000 scale (about 1 inch = 16 miles).
(*ii*) La Carte Internationale du Monde on the 1:1,000,000 (about 1 inch = 16 miles).
(*e*) Geographical maps on the 1:2,000,000 scale (about 1 inch = 32 miles).
(*f*) General maps on the same and smaller scales.
(*g*) Special maps.

The progress made in the publication of each of these classes is detailed below:—

(a) **Topographical maps on the one-inch scale.**—During the year 45 modern sheets have been published.

Index map No. 2 at the end of this report shows the progress made in the publication of the modern one-inch public sheets, and the following table gives the annual output of these sheets since the modern topographical surveys were begun:—

Years of publication.	Number of one-inch sheets published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
1915-16	85	69	50	204
1916-17	23	40	22	85
1917-18	18	12	13	43
1918-19	32	19	6	57
1919-20	15	37	52	104
1920-21	**15**	**11**	**19**	**45**
Total published ...	706	502	520	1,728
Probable number of one-inch sheets which will not be published owing to the area covered by them being included in the programme for survey and publication on the half-inch scale	911	564	473	1,948
Approximate number remaining for publication	535	963	1,044	2,542
Approximate number of public one-inch sheets in India	2,152	2,029	2,037	6,218

In addition to the above, preliminary editions (in colours) of 20 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision. Also 1 provisional issue.

96 modern one-inch, 29 preliminary editions of one-inch, and 49 old style one-inch sheets have been reprinted during the year.

(b) **Topographical maps on the half-inch scale.**—Index map No. 3 at the end of this report shows the progress made in the publication of the modern half-inch public sheets. This series now forms the *tactical* map of India, having taken the place of the quarter-inch maps in this respect. It was commenced in 1914; most of the sheets published up to date are reductions from the one-inch map, but others are from direct half-inch surveys.

The following table gives the annual output of these sheets :—

Years of publication.	Number of half-inch sheets published.		
	Drawn from component one-inch sheets.	Surveyed on half-inch scale.	Total.
1914-15	...	1	1
1915-16	21	4	25
1916-17	50	6	56
1917-18	59	6	65
1918-19	26	4	30
1919-20	31	8	39
1920-21	**59**	**2**	**61**
Totals	246	31	277
Approximate total number of half-inch sheets in India	.....	.....	1,630

In addition to the above, a preliminary edition (in colours) of one half-inch sheet prepared from old half-inch material, has been published during the year.

3 modern public half-inch sheets have been reprinted during the year.

(c) **Topographical maps on the quarter-inch scale.**—These maps are prepared in "degree" sheets which include 1° of latitude and 1° of longitude, *i.e.*, the area covered by 16 one-inch sheets, or 4 half-inch sheets.

Index map No. 4 at the end of this report shows the progress made in the publication of the modern quarter-inch public sheets.

The following table gives the annual output of these sheets :—

Years of publication.	Number of "Degree" sheets published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	1	3	3	7
1915-16	...	1	4	5
1916-17	1	...	3	4
1917-18	...	...	4	4
1918-19	...	3	8	11
1919-20	4	...	4	8
1920-21	**1**	...	...	**1**
Totals	16	12	33	61
Approximate number of "degree" sheets in India	170	140	140	450

6 preliminary sheets in colours from comparatively modern surveys have been published and 13 are in hand.

In addition to the above, 15 modern public quarter-inch sheets have been reprinted during the year.

3 "degree" sheets have been prepared in No. 1 Drawing Office from the old engraved quarter-inch Atlas sheets brought up to date and published (in black only) as provisional issues; and 18 of such sheets which were published previously have been reprinted during the year. These "provisional" degree sheets, including those in hand, now cover the greater part of the area of India for which modern "degree" sheets are not likely to be available for some time.

(d) **Geographical Maps on the 1:1,000,000 scale.**—*(i)* **The "India and Adjacent Countries" Series** (*Vide* Index map No. 5).—During the year 6 new sheets of this series have been published, 4 sheets have been engraved and 23 sheets have been reprinted.

(ii) **La Carte Internationale du Monde.**—(*Vide* Index map No. 6).—A full description of the genesis of this series was given in the General Report for 1913-14; 2 sheets of this series have been published during the year. 10 sheets have been published up to date.

(e) **Geographical Maps on the 1:2,000,000 scale.**—(*Vide* Index map No. 7).—No new map of this series was published during the year. It has been decided to engrave the sheets of this map on two plates only, one for outline and one for the hill features.

(f) **General Maps on the same and smaller scales.**—The engraved plates of all these maps have been corrected and brought up to date as far as possible during the year.

(g) **Special maps.**—The annual edition of the Railway Administration map (on the scale of 1 inch = 64 miles) has been published during the year; four provincial maps and the map of India and Adjacent Countries (on the scale of 1 inch = 64 miles) have been reprinted.

Numerous special maps have also been prepared and printed for the Army, for Local Governments, Railways and for other Departments.

Most of the "Town-guide" maps, on the scale 12 inches = 1 mile, of several of the larger Indian cities, which were under preparation, have been published.

The "Town-guide" maps of Agra, Barrackpore, Dum Dum and Cawnpore were published during the year.

A map of Mount Abu on scale 1 inch = 220 feet has been published, 5 Cantonment maps were also reprinted during the year.

52. Map Record and Issue Office.—During the year under report there has been a somewhat larger demand for maps than during the previous year resulting in an increase in map issues to government officials.

The feature of this year's report is the heavy number of publications (departmental and extra-departmental) received in this office for storage and issue, *viz.*, 435,745 copies valued at Rs. 1,27,350 in excess of those received during 1919-20, involving heavy work in dealing with receipts and registration of printed maps.

To meet the demands for more up to date information in respect of the maps that are available, a new catalogue has been prepared and will be issued shortly.

Issues.—FROM MAP RECORD AND ISSUE OFFICE, 1920-21.

YEAR.		ON BOOK DEBIT (TO GOVERNMENT OFFICIALS).		ON CASH PAYMENT (TO PRIVATE INDIVIDUALS AND MAP AGENTS).		FREE ISSUES (DEPARTMENTAL AND TO INDIA OFFICE).		TOTAL.	
		Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.
1920-21	Departmental.	69,280	64,884	38,585	45,934	56,661	27,905	164,526	1,38,723
	Extra-departmental.	1,524,588	1,41,518	98,143	13,634	163	270	1,622,894	1,55,422
	Total ...	1,593,868	2,06,402	136,728	59,568	56,824	28,175	1,787,420	2,94,145
1919-20	Total ...	1,271,851	1,66,823	136,971	55,468	77,044	50,859	1,485,866	2,73,150
1918-19	Total ...	2,227,010	3,87,085	101,222	47,663	37,204	32,539	2,365,436	4,67,287

Table IV.—Publications received in Map Record & Issue Office, during the year 1920-21.

A.—From the Calcutta Printing Offices, (including the Engraving Office).

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	Reprints and New Editions.		
		DEPARTMENTAL.			
GENERAL MAPS.					*Rs.*
Maps of India	Various	...	2	2,594	3,920
GEOGRAPHICAL MAPS.					
Map of India	1″=32 miles	...	...	...	...
Southern Asia Series	1:2,000,000	...	...	...	...
India and Adjacent Countries Series	1:1,000,000	6	23	13,870	20,532
La Carte Internationale du Monde	1:1,000,000	2	...	600	600
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern	1″=4 miles	12	33	18,030	25,832
Do. (Prely.)	1″=4 miles	37	12	26,690	39,474
Do. (Provl.)	1″=4 miles	3	18	6,930	9,908
Half-inch, Modern	1″=2 miles	74	7	40,700	59,553
Do. (Prely.)	1″=2 miles	1	...	500	750
One-inch, Modern	1″=1 mile	45	96	77,985	1,07,326
Do. (Prely.)	1″=1 mile	20	29	24,134	35,076
Do. (Provl.)	1″=1 mile	1	...	100	150
Old Style sheets	Various	...	49	12,049	16,576
SPECIAL MAPS.					
District Maps	1″=4 miles	...	2	600	413
Administration Report Maps ...	1″=8 miles	...	2	100	38
Provincial Maps	Various	...	4	2,681	4,695
Plans of Cities and Cantonments ...	Various	5	5	7,327	15,696
Index Maps	Various	1	17	11,390	2,686
Miscellaneous Maps	Various	22	17	24,577	19,855
Total	.....	**229**	**316**	**270,857**	**3,63,080**
		EXTRA-DEPARTMENTAL.			
Maps	Various	64	70	245,290	49,209
Plans and diagrams	Various	122	13	534,042	63,678
Illustrations	.....	65	4	167,743	17,594
Miscellaneous	.....	51	39	677,284	26,709
Total ...	.....	**302**	**126**	**1,624,359**	**1,57,190**
Grand Total	.....	**531**	**442**	**1,895,216**	**5,20,270**

B.—From the Trigonometrical Survey Office, Dehra Dūn.

Various	.....	...	26	4,200	6,540

C.—LETTERPRESS.

1. Survey of India General Report, 1919-20. *Price Rs. 2 or 4s.*

53. No. 1 (Head Quarters) Drawing Office.—The organization of the office remained substantially the same as last year.

The work carried out by the various sections was as follows:—

(1) *The Compilation Section.*—

(*a*) "La Carte Internationale du Monde au 1,000,000e".—Two of the three sheets sent in for publication during 1919-20 were published during the year under report. One sheet was completed and sent for publication. Seven new sheets were taken up. Outline patterns of four of these sheets have been supplied to the Engraving Office, the remaining three sheets are in hand.

(*b*) The Southern Asia Series, scale 1:2,000,000.—Five sheets were reported in hand last year, two new sheets were taken up this year. Of these seven sheets, complete outline patterns for four sheets and partly complete patterns for two were supplied during the year to the Engraving Office. The outline pattern for the remaining sheet is in hand.

(*c*) Miscellaneous.—Originals for the following were prepared and submitted for publication:—

(*i*) Index chart showing limit of responsibility for mapping and survey between the War Office, Egypt and India.

(*ii*) Type table for topographical maps.

Print originals of the following were prepared and submitted for publication:—

(I) Index to half-inch sheets of the East Persia Party.

(II) Index to F. O. U. O. half-inch sheets for the General Report (Confidential Supplement).

(III) Index to publication of the one-inch, half-inch and quarter-inch and 1/M sheets for the Chief of the General Staff.

Patterns for the following were supplied to the Engraving Office for engraving plates:—

(1) Standard Index chart No. 92.

(2) Index to 1/2M sheets.

Patterns for the correction and reprint of the layered edition of the 32-mile map of India were prepared.

Indexes were kept up to date.

(2) *The "One-Millionth" Section.*—

(*a*) Of the engraved editions (original and modernized) at the end of last year there were ten sheets in hand, one new sheet was taken up during the year under report. Of these 11 sheets, complete outline and contour patterns of 7 were sent to the Engraving Office, patterns for the remaining four sheets are in hand.

(*b*) Helio editions.—(original). One sheet has continued in hand during the year.

(*c*) The original of 1 sheet has been corrected and sent to press for reprint, and four other sheets for reprint (helio edition) are in hand.

(*d*) Miscellaneous.—A type table for topographical maps, card indicator scales, colour patterns for the new map catalogue, corrections to the 1/M border specimen for reprint were completed and the original engraved patterns of two sheets prepared at Dehra were corrected after examination before being sent to the Engraving Office.

(3) *The Quarter-Inch Section.*—Of the nine quarter-inch sheets (preliminary editions) shown as in hand at the end of last year, one sheet has been completed and sent to press. Two have been completed and are about to be sent to press. The fair-drawing of two sheets is well advanced and the rough compilation of the remaining four sheets is finished and under examination.

Eleven quarter-inch sheets were in hand at the beginning of the year for reprint. Of these, three (modern) sheets and five F. O. U. O. sheets were corrected to date and sent for publication, one sheet (preliminary edition) was prepared from a print original of the outline and a new contour original was drawn, the completed sheet being sent for reprint, the remaining two sheets (preliminary edition) are completed as to print original of outline, but the drawing of new contour originals is still in hand.

Five new quarter-inch sheets (preliminary edition) taken up during the year are in hand. The original of one sheet (preliminary edition) was corrected, brought up to date and sent for reprint.

In addition, boundary colour guides for two sheets and a stump-shaded original for one sheet were prepared.

(4) *The Reprint Section.*—Owing to the great increase in the reprint work and also to the heavy demands made upon the office for extra-departmental and special maps it was found necessary to divide the Mapping and Reprint Section into two sections, known as, the Reprint Section and the Mapping Section. The former deals now entirely with old style reprint work and degree sheets compiled from the Indian Atlas, and the latter with all special maps whether departmental or extra-departmental and all reprints of modern maps (*vide* sub-para. 5).

The work of the Reprint Section for the year was as follows:—

41 old style (15″×30″) one-inch sheets were corrected and sent for reprint; of these 6 were fragmentary but were completed to edges; 16 sheets are still in hand.

26 one-inch sheets were converted to modern graticule, corrected and sent for reprint as 15″ × 15″ sheets, of these 15 were fragmentary but were completed to edges from all available material; one sheet is still in hand.

21 degree sheets were compiled from the Indian Atlas and other material and sent for reprint. Of these 5 were fragmentary but were completed to edges from 1/M material. Twelve sheets remain in hand.

17 degree sheets, compiled from Indian Atlas material, were corrected against office copies and sent for reprint, five sheets remain in hand.

2 Atlas sheets were corrected against office copies and sent for reprint.

Total number of sheets sent for reprint ... 107.
,, ,, ,, remaining in hand ... 34.

The above out-turn represents a 30% increase over last year.

(5) *The Mapping Section.*—

(*a*) 125 modern topographical sheets were corrected and brought up to date against office copies and sent for reprint, 2 sheets remain in hand.

(*b*) The original of the 64-mile (departmental) Railway map of India was brought up to date and sent for reprint. Five other miscellaneous cases are still in hand.

(*c*) Press order proof corrections have been inserted on the original fair sheets of 220 modern topographical sheets and three 1 : 1,000,000 scale sheets after publication, corrections to fourteen modern topographical sheets are in hand.

(*d*) The fair sheets of 25 special maps on various scales have been drawn for other government departments, &c., and sent to press. These include maps for H.R.H. The Prince of Wales tour, railway, census, commercial, military and other maps.

(*e*) Black prints of plane-table sections of 16 sheets were pasted together and sent to the Photo.-Litho. Office for supply to parties of blue prints for fair-drawing.

(*f*) Minor corrections to 1,800 stock copies of modern maps were made by hand, for the Map Record and Issue Office.

(6) *The Office Copy Section.*—

(*a*) Additions and corrections have been entered on the existing "office copies" of 2,368 published sheets; 559 "office copies" of newly published or reprinted sheets have also been prepared during the year.

(*b*) The miscellaneous work of the section included questions relating to revenue survey maps, and the supply of authenticated copies of records to officials and private persons. The areas of 74 newly published one-inch and half-inch maps were checked against the Auxiliary Tables and the areas were entered in the Area-Register.

(7) *The Examining Section.*—This section is responsible for the examination of the sheets drawn by other sections in the office and also for the general scrutiny of a considerable number of sheets fair-drawn in other circles and drawing offices.

187 cases affecting 257 fair sheets have been dealt with by this section during the year. 11 cases affecting 11 fair sheets remain in hand.

In addition to the above current work, the section supplied scientific data to various officials, kept up corrections to Imperial Gazetteers, examined projections on copper of sheets in the Engraving Office, checked geographical names in various Survey of India publications, corrected press copies and prepared indexes for the same, drafted corrections to various departmental hand-books, type and conventional sign tables and border specimens; prepared diagrams illustrating professional orders and papers, and carried out much other miscellaneous work.

54. Engraving Office.—(1) *Engraving Section.*—The engravers have been chiefly employed on—

(*a*) India and Adjacent Countries on the 1:1,000,000 scale.— Of the six plates remaining in hand, four have been completed

and two are nearing completion. Of six new sheets projected during the year, one is nearing completion, three are well in hand and two are projected only.

(*b*) "La Carte Internationale du Monde", scale 1:1,000,000.—The two sheets completed last year have been published. Of the four sheets projected last year, one is approaching completion and the remaining three are well in hand. No new sheets were projected.

(*c*) Southern Asia Series, on the 1:2,000,000 scale.—One (Colombo) taken up during the year is completed, two (Brahmaputra and Madras) which remained in hand from last year are well advanced, and three new sheets are in hand, *i.e.*, Bombay, Delhi and Calcutta, and one new sheet (N. Tibet) projected.

(*d*) In addition to above, periodic corrections have been carried out on the plates of all the general maps of India on various scales. The boundary symbols of most of the 1/32-mile index sheets have been changed to make them appear more prominent, and other improvements have been engraved on 27 out of 46 indexes and 6 others are in hand. Thirteen pages of an approved copy book of different styles of lettering for use of Survey students, draftsmen, &c., have been engraved. A new large tint plate has been ruled for the Photo.-Litho. Office, size 41″ × 27″. A new border specimen has been engraved for the Southern Asia Series, 1:2,000,000 scale, also a new index for the latter. A number of titles has been engraved for photogravure plates and several old plates that were worn out have been repaired. One district map is being brought up to date with modern graticule.

(*e*) As a result of exhaustive enquiry, a graphic system of controlling the work of the office has been instituted and a full programme of work for two years ahead has been laid down, which will absorb the full capacity of the establishment.

(2) *Copper Plate Printing Section.*—32,502 impressions were pulled during the year compared with 29,040 during the previous year; 12,550 of these prints were scales and charts, 9,000 photogravures, 1,895 India Atlas sheets and 9,057 were from miscellaneous plates including prints on parchment and transfers.

The amount of extra-departmental work included in the above was 9,753 impressions or about 30 per cent. Sixty-one plates were dealt with in the Steel-facing branch.

55. Photo.-Litho. Office.—The *Litho.* out-turn although apparently smaller than last year, is really better for the following reasons:—

(*i*) Total number of pulls is considerably larger.

(*ii*) All sheets printed during the year have had their coloured boundaries machine-printed, whereas formerly this was not the case. This implies one or more extra printings as a rule.

(*iii*) During the war a large demand was made for reprints of frontier and trans-frontier sheets from standing plates, whereas practically all the reprints published during the year are similar to new sheets, that is, the originals had as far as possible been brought up to date, necessitating re-photography and a complete set of new plates.

The *Type Section* out-turn has improved considerably, chiefly on account of the longer runs per item, although the total number of items has been steadily decreasing during the last four years.

One new "Laureate" platen press was received from England for the *Process Engraving Section* towards the end of the year.

The following tables briefly summarize the record of the office for the past 3 years:—

TABLE A.

1	2	3	4	5	6
Year.	* Cost of office.	Value of out-turn at cost-rates.	NUMBER OF MAPS PRINTED.		
			Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*			
1918-19	2,21,218	4,54,243	637	4,203	4,840
1919-20	2,20,643	4,19,636	786	3,118	3,904
1920-21	**2,70,193**	**4,77,839**	**625**	**2,546**	**3,171**

* Does not include cost of chemicals, paper, &c., obtained from England.

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	TYPE SECTION OUT-TURN.		
				Pages or items published.	Copies printed.	Impressions pulled.
1918-19	4,248,913	183,413	1,151,678	5,577	1,233,211	1,829,380
1919-20	3,013,622	122,522	727,255	4,656	1,564,552	2,742,584
1920-21	**3,736,999**	**237,976**	**501,265**	**3,429**	**2,034,962**	**3,609,532**

TABLE C.

PHOTO. BRANCH.

	1918-19.	1919-20.	1920-21.
Negatives	4,190	6,658	**5,786**
Zinc plates	7,227	9,161	**7,591**
Photogravure plates	554	544	**490**
Half-tone blocks			
Line blocks			

56. Mathematical Instrument Office.—During the year from 1st April 1920 to 31st March 1921, there was a decrease in the demands made on this office (*vide* item 1 in para. 2), and an increase in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 35,681 and Rs. 26,793 against a profit of Rs. 71,839 and Rs. 20,109 in 1919-20.

2. The following table shows the usual comparative figures for the last 3 years :—

	1918-19.	1919-20.	1920-21.
	Rs.	*Rs.*	Rs.
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	7,64,795	5,54,959	4,74,911
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	50,904	48,002	96,089
3. Value of instruments received from Government Officers when no longer required.	1,33,730	51,503	70,484
4. Book value of the stock of instruments, &c., in Serviceable Stores.	4,22,818	4,06,059	5,06,988
5. Book value of the stock of instruments, &c., in Repairable Stores.	1,10,554	79,057	1,07,873
6. Total value of work done in the Workshop ...	4,35,023	3,67,343	4,81,809
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	2,17,342	1,95,907	1,82,644
8. Value of instruments purchased locally ...	2,72,462	70,276	41,063
9. Value of instruments and materials obtained from England through the Director General of Stores.	67,174	1,57,694	2,98,795
10. Average No. of employees and their pay ...	No. 556 Rs. 1,63,759	No. 599 Rs. 1,28,770	No. 618 Rs. 1.77.655

3. During the year the stock of all the three stores (the Serviceable, the Repairable and the Material Stores), was twice taken, and the discrepancies noticed have been adjusted.

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

57. Computing Office.—During the year under review the adjustment of the stations and intersected points of the following geodetic series was carried out:—

(*a*) Kashmīr Principal Series.
(*b*) Indo-Russian connection.
(*c*) Mönghsat Secondary Series.
(*d*) Mawkmai Secondary Series.
(*e*) Pendant portion of the Kashmīr Principal Series.
(*f*) Kāgān Secondary Series.
(*g*) Changchenmo Secondary Series.
(*h*) Rupshu and Bārā Lācha Secondary Series.
(*i*) Upper Indus Secondary Series.

The adjustment of heights of the following geodetic series was also completed during the year under review:—

(*a*) Khāsi Hills Secondary Series.
(*b*) Jaintiā Hills Secondary Series.
(*c*) Mawkmai Secondary Series.
(*d*) Mönghsat Secondary Series.

Computations were carried out in connection with the following:—

(*a*) Auxiliary Tables, Part III, 5th Edition.
(*b*) The remodelling of computation forms and adapting them to paper of foolscap size.
(*c*) Graticules of maps for Sir Aurel Stein and No. 2 Drawing Office.
(*d*) Longitude by wireless telegraphy (Dehra Dūn).
(*e*) Deflections of the plumb-line, Bouguer and Hayford corrections for pendulum stations and heights of gravity stations in Turkistān.
(*f*) Meteorological results.
(*g*) Regrinding of a figure in the Burma Coast Series.
(*h*) The adjustment of Mr. Bond's stations in Assam (region of 1897 earthquake).
(*i*) The formula for barometric heights.
(*j*) The height of Mount Everest.

Final corrections were applied to latitude, longitude, azimuth, log: side, and heights of stations and intersected points of triangulation falling in some 70 Degree sheets in Burma, N.-W. Frontier and trans-frontier regions.

120 Degree triangulation pamphlets were compiled, of which 104 were also compared; 87 pamphlets were sent to and 51 pamphlets passed through the press.

The Professional forms of the department were of different sizes, which is inconvenient for storage. It has therefore been decided to convert them to foolscap size, and the opportunity has been taken to improve the arrangement of the forms where possible.

Type Printing Section.—The following publications were printed during the year:—

1. Professional Papers Nos. 18 and 19 (print and reprint).
2. Auxiliary Tables, Parts I, II (reprint) and 19 Tables of Part III (set up and partly printed).

3. Levelling pamphlets No. 54 (reprint) and No. 44 (addendum) and slips for eight levelling pamphlets.
4. Catalogue of Library Books.
5. Triangulation pamphlets covering 51 Degree sheets.

Observatories.—Meteorological observations were continued as usual. The Omori seismograph was in operation throughout the year. Tremors of violent intensity were recorded on the 17th December 1920 (epicentre at Piang Liang, China). Photographs of the sun were taken on 320 days, the sun being obscured on the remaining days of the year.

Preservation of Triangulation Stations.—750 stations were repaired by the district officers at a cost of Rs. 5,108. Out of 359 districts from which reports were due, 13 failed to send returns.

Research.—The main heads of research were :—

(*a*) Longitude by wireless signals from Paris,

(*b*) Investigation of atmospheric refraction,

(*c*) Adjustment of minor triangulation net-work.

A short account of progress made in these matters is given in Records of the Survey of India, Volume XVI.

58. No. 2 (Dehra) Drawing Office.—During the year under report the work of this office was carried out by six sections. The personnel of the *Field Section* was absorbed into the other sections and the section was done away with.

(1) *The Triangulation Chart and Cantonment Section.*—Deals with the fair-drawing of triangulation, levelling and index charts, and the publication, reprint and correction of cantonment plans. In addition to the ordinary work of this section, 128 miscellaneous maps, charts, and diagrams (of which 13 were fair-drawn) were dealt with and sent to press, and 158 sheets were hand-coloured.

(2) *The Compilation Section.*—Deals with the compilation and fair-mapping of geographical maps on different scales. One fair sheet on 1/M scale shown as in hand last year was completed and sent to press. Of the 10 sheets of rough compilation on 1/M scale, shown in hand last year, two sheets are being fair-mapped, and two sheets have been sent to Calcutta to be engraved, leaving a balance of 6 sheets in hand. The stump-shading for 6 sheets on different scales was taken in hand this year; two have been completed and sent to press. Of the rough compilation of sheets on the 1/2M scale, 3 were in hand at the beginning of the year and 2 more were taken up during the year; one sheet was completed, and sent to Calcutta to be engraved, leaving a balance of 4 in hand. The section has also taken up the fair-mapping of 7 half-inch sheets, which are all in hand.

(3) *The Stein Section.*—Deals with the fair-mapping of Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906—08 and 1913—15. The 14 sheets shown as in "proof in colour" stage, and the 8 sheets shown as sent to press last year, have all been published during the year. This, added to 21 sheets of this series already published, brings the total of published sheets to 43. In addition to 4 sheets in hand, two more sheets were taken up during the year; of these 5 sheets have been sent to press and one sheet is in hand.

(4) *The Half-inch Section.*—Deals with the fair-mapping of half-inch sheets. 12 sheets were in hand at the end of last year, 32 sheets were received during the year; 8 sheets have been sent to press and 36 sheets are in hand.

(5) *The Examining Section.*—Examines the majority of the important sheets drawn in this office, and instructs the pupil draftsmen in drawing, hand-printing, and the use of drawing instruments. 85 sheets on various scales were examined and disposed of during the year.

(6) *The Map Record Section.*—Deals with the storage of originals and office copies of cantonment plans, triangulation and other charts, and geographical maps, and keeps a small stock of all maps published by the department for occasional issue to the public and for departmental use. It also deals with the despatch of all sheets printed in Dehra Dūn, and with all correspondence on the subject.

The following is the summary of the work of the office during the year 1920-21 :—

Class of maps.	Balance of sheets on 1st October 1920.	Sheets received in 1920-21.	Sheets sent to press in 1920-21.	Balance of sheets in hand on 1st October 1921.	REMARKS.
Triangulation charts ...	11	32	25	18	
Levelling charts, scale 1/M	1	2	2	1	
Index charts to illustrate reports.	.....	4	3	1	
Cantonment plans for publication.	59	152	118	93	Corrections and additions made and sent to press.
Cantonment plans for correction.	53	8	57*	4	*Corrections carried out in both originals and office copies and stored.
Miscellaneous maps, charts and diagrams.	.....	129	128	1	
Colour guides	450†	75	158	70	†285 sheets of Hyderābād Forests transferred to Forest Map Office and 12 sheets pending publication.
GEOGRAPHICAL MAPS.					
Fair sheets, scale 1/M ...	1	2	1	2	
Rough compilation, scale 1/M	10	.....	4‡	6	‡Two sheets are being fair-drawn and 2 sheets have been sent to Calcutta for engraved edition.
Rough compilation, scale 1/2M	3	2	1	4	For engraved edition.
Stump-shading	.....	6	2	4	
Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906—08 and 1913—15, for publication on 2/M scale.	4	2	5	1	One sheet is in 'proof in colour stage'. The 14 sheets which were in 'proof in colour stage' and 8 sheets which were sent to press last year have all been published during the year under report.
Half-inch sheets ...	12	32	8	36	

Photo.-Zinco. Section.—During the year 1920-21, the work undertaken comprised :—

Cantonment maps.
Indexes and Triangulation charts.
Forest maps.
Sir Aurel Stein's maps.
Miscellaneous maps.
Extra-departmental maps.

The group of 4 technical hands sent to Baghdād to re-inforce the Mesopotamian Survey Party, returned to Dehra Dūn during the year.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Bromide prints.
1918-19 ...	1,193	1,475	275,276	229
1919-20 ...	1,414	2,087	316,114	562
1920-21 ...	**1,430**	**1,911**	**436,996**	**447**

59. Forest Map Office.—The classes of work entrusted to the four technical sections of this office have been described in a previous report; the distribution of work has been continued on the same lines; and the progress made during the year under report is described below :—

(1) *The Drawing Section.*—The progress of this section is shown in the table below :—

Class of map.	In hand on 1st October 1920.*	Received during the year.	Drawn and sent for publication during the year.	In hand on 30th September 1921.	Published during the year.	Total number of copies printed.
(*a*) ...	32	77	106	3	110	30,588
(*b*) ...	37	99	42	94	44	
(*c*) ...	16	4	7	13	8	
(*d*) ...	12	6	14	4	24	
(*e*) ...	.....	7	7	.....	12	
(*f*) ...	6	22	9	19	18	
(*g*) ...	50	28	73	5	62	
Total ... 1920-21.	**153**	**243**	**258**	**138**	**278**	
Total ... 1919-20.	.....	192	205	.....	211	21,823

* These figures have been revised since last year's report and are now correct.

(*a*) Reprints of Forest maps on various scales.
(*b*) Forest editions, on the scale of 2 inches = 1 mile, of modern one-inch maps.
(*c*) Maps of Forest Circles and Divisions.
(*d*) Maps to illustrate working plans, &c.
(*e*) Maps and diagrams to accompany Administration Reports.
(*f*) Forest maps from special surveys, mostly on the scale of 4 inches = 1 mile.
(*g*) Index and miscellaneous maps.

(2) *The Portfolio Section.*—Office copies of 31 maps and colour specimens of 64 maps were prepared, corrections on 60 sheets were completed, and 2,687 sheets were coloured by hand for issue, all the office copy corrections to be made from notifications received during the year were fully carried out.

(3) *The Map Record Section.*—The number of maps, diagrams and other records, received for storage was 7,921. 6,068 maps, &c., valued at Rs. 10,265 were issued. Sales by book-transfer to government departments amounted to Rs. 3,700 for 1,982 maps, &c., these figures show a decrease of 11,948 maps and Rs. 5,459 under those for last year. Cash sales to the public amounted to Rs. 1,762 for 1,139 maps, a decrease of Rs. 1,963 under the amount realized the previous year.

(4) *The Book-Binding Section.*—This section dealt with 487 volumes for the Forest Research Institute, the value realized being Rs. 1,249, an increase of 59 volumes and Rs. 236, over the figures for last year. In addition 136 envelopes and leather cases were made and the cost, *viz.* Rs. 72, realized by book-transfer; 2,168 maps of various sizes were mounted on cloth for issue.

60. At the special request of the Officer in charge, Map Record and Issue Office, Calcutta, the Drawing Section prepared a complete set of Index maps showing the areas published on the two-inch and four-inch scales together with a few specimens of the maps published by this office for insertion in the new edition of the Survey of India Catalogue of Maps.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

61. No. 3 Drawing Office (Northern Circle).—During the year 16 two-inch sheets out of 35 and 16 one-inch sheets out of 39 previously surveyed were fair-mapped by parties and have been submitted for publication. In addition to these, 2 one-inch sheets were re-drawn in the Circle Drawing Office and 5 half-inch sheets were brought up to date and completed to edge in No. 1 Party's office and submitted for publication.

Half-inch sheets compiled from modern one-inch and old style half-inch sheets.—34 half-inch sheets, 30 of which were drawn in the Circle Drawing Office, have been submitted for publication during the year.

Modern material available.—All half-inch sheet areas of which component one-inch sheets have been published have now been disposed of; the fair-mapping of 14 sheets being in hand in the Circle Drawing Office while that of 41 sheets has been allotted to No. 2 Drawing Office. In addition to the above, there are 26 half-inch sheet areas of which some of the component one-inch sheets, though surveyed, have not been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch and old style sheets.—During the year 3 quarter-inch sheets were fair-mapped in the Circle Drawing Office and submitted for publication.

Modern material available.—There are 26 quarter-inch sheet areas of which the component one-inch or half-inch sheets have been published; of these the fair-mapping of 7 sheets is in hand. In addition to the above there are 11 quarter-inch sheet areas of which the component one-inch or two-inch sheets though surveyed have not been submitted for publication.

Special maps.—During the year the Environs map of Lahore, scale four inches = 1 mile, the Royal Artillery Practice Camp map of Kutwa-Mirzāpur survey, scale three inches = 1 mile, the Guide Map of Mount Abu survey, scale six inches = 1 mile and the Mussoorie City Map survey, scale twenty-four inches = 1 mile, were fair-mapped and submitted for publication.

The colour patterns of 7 Town-guide and Environs maps, scale twelve inches and four inches respectively = 1 mile; 4 sheets of the Delhi and Vicinity, scale four inches = 1 mile, were prepared and submitted for publication.

Hill-shaded sheets.—64 one-inch and half-inch sheets were stump-shaded and submitted for publication.

Layer guides.—Nil.

Colour patterns and press order proofs.—Press order proofs and colour patterns of 107 sheets were submitted for publication. In addition to these, the yellow and green colour patterns of 16 sheets were specially prepared and submitted during the year for future reprint purposes.

Miscellaneous.—The traverse plots of 26 *mauzas* in 44 sheets, scale sixteen and thirty-two inches = 1 mile, of the Gondā district and of 17 sheets, scale sixteen inches = 1 mile, of the Naini Area, Allahābād district, were supplied and the cost of preparation recovered from the Deputy Commissioner, Gondā, and the Chairman, Allahābād Improvement Trust, respectively.

For the purpose of reprint, the office copies of 35 one-inch sheets were corrected and submitted for publication during the year.

The fair sheets of 21 one-inch and 16 half-inch sheets were brought up to date and submitted for reprint during the year.

62. No. 4 Drawing Office (Southern Circle).—During the year, 42 one-inch sheets previously surveyed and mapped by parties were finally examined and submitted for publication. There are no arrears.

Half-inch sheets previously surveyed on the half-inch scale and mapped by parties.—4 sheets were finally examined and submitted for publication. There are no arrears.

Half-inch sheets compiled from modern one-inch sheets.—4 sheets mapped by parties were finally examined and submitted for publication. The half-inch section which is employed on this class of mapping was transferred to No. 4 Drawing Office from the 1st August 1921 and has in hand 9 sheets of which 7 are well advanced and will be submitted for publication early in 1922.

Modern material available.—The material for 2 sheets has been received but the mapping has not yet been commenced. The material for 7 sheets of which the component one-inch sheets are under publication, is expected shortly. There are 12 half-inch sheet areas completely surveyed on the one-inch scale but of which all the component one-inch sheets have not yet been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch and old style sheets.—3 sheets were mapped and submitted for publication. There are 18 sheets in hand of which 2 will very shortly be submitted for publication.

Modern material available.—There is one sheet of which the half-inch sheets are published or under publication and for which the material has been asked for and in addition there are 9 sheets of which the areas have been completely surveyed but of which the component half-inch sheets have not yet been submitted for publication.

Reprint sheets.—1 half-inch sheet and 5 quarter-inch sheets were corrected and submitted for publication.

Colour patterns.—Were prepared and submitted to the Superintendent, Map Publication for 59 sheets.

Hill-shaded sheets.—Were prepared and submitted to the Superintendent, Map Publication for 26 sheets.

Layer guides.—Were prepared and submitted to the Superintendent, Map Publication for 2 sheets.

Triangulation charts.—2 were finally examined and submitted for publication before this class of work was handed over on the 1st May 1921 to the Record Section.

Photo.-zinco. work.—Number of reproductions 257
„ „ enlargements 150
„ „ reductions 205
„ „ Vandyke plates prepared ... 198
„ „ prints pulled 11,397

Special maps.—A three-inch military map of Secunderābād and Bolārum mapped by No. 6 Party is under examination and will very shortly be submitted for publication. A one-inch map of Shīrāz (Persia) mapped by No. 6 Party will on receipt of certain information from the General Staff be completed and submitted for publication. 15 two-inch sheets of the special forest survey of Hyderābād (Deccan) which have been mapped by No. 6 Party are under final examination and will shortly be submitted for publication.

Miscellaneous.—Preparation of index maps.

The usual training in drawing and typing was given to pupil surveyors and pupil draftsmen.

63. No. 5 Drawing Office (Eastern Circle).—During the year, 3 four-inch, 6 two-inch, 28 one-inch and 5 half-inch sheets fair-mapped

by parties were received in the drawing office. There was 1 one-inch sheet in hand from the last report, making a total of 43 sheets.

Of these, 42 sheets were submitted for publication and one one-inch sheet was returned to the party for incorporation and publication on the half-inch scale.

Half-inch sheets compiled from modern one-inch and old style sheets.—There were 33 sheets under drawing during the year, of which 15 were in hand at Maymyo and 18 in the drawing office. 22 sheets were submitted for publication, leaving 11 in hand in the drawing office.

Modern material available.—Exclusive of the sheets being drawn, there are 20 half-inch sheets in the circle, of which the component one-inch sheets have been published.

Quarter-inch sheets compiled from modern one-inch, half-inch and old style sheets.—Of the 7 quarter-inch sheets noted as in hand, and one in abeyance, in the previous report, 4 have been submitted for publication during the year, leaving 3 in hand and one in abeyance pending the completion of recent half-inch surveys for incorporation. The fair-mapping of 1 quarter-inch sheet was started during the year.

Modern material available.—There is 1 sheet, the fair-mapping of which has yet to be undertaken in the circle, of which the component half-inch sheets have been published.

Special maps.—The fair-drawing of two sheets of the Syriam-Kyauktan survey on the three-inch scale, for reproduction, was undertaken by the drawing office during the year; both sheets will shortly be submitted for publication.

Hill-shaded sheets.—42 shaded sheets were submitted for publication during the year, including the 7 in hand at the close of last year. There are no arrears.

Layer guides.—5 layer guides were submitted, including 2 in hand at the close of last year. There are no arrears.

Colour patterns and press order proofs.—Press order proofs for 52 sheets and colour patterns for 53 sheets received during the year, including 10 in hand at the close of last year, were submitted for publication. There are no arrears.

Triangulation charts and traverse data.—The section formed during the previous year for the preparation of charts and for the sorting, numbering, indexing and registering of all computation volumes and data &c., in the circle office and parties, prepared and submitted for publication 10 charts with their pamphlets and data. The preparation of 11 charts of degree sheets in Burma is in abeyance pending the preparation and publication by the Superintendent of the Trigonometrical Survey of the preliminary G. T. pamphlets.

The triangulation charts and pamphlets of 2 degree sheets, for which the preliminary pamphlets have been published, remain to be prepared when an officer is available for the work.

64. No. 6 (Simla) Drawing Office.—The *Army Section* has dealt with the preparation and printing of maps and plans for the use of the Army and other Government Departments.

The *Survey Section* has been employed on the preparation of trans-frontier maps on the one-millionth and quarter-inch scales, and incorporating additional information on those previously published.

65. Bengal and Bihār and Orissa Drawing Office.—(Imperial Standard Mapping Section). This section has been employed as usual on (*a*) the compilation from modern revenue survey material and

from other maps and (*b*) the fair-mapping of the preliminary editions of modern one-inch sheets in colours pending their topographical revision. The sheets are completed from old material in cases where no modern work is available.

This section has now been divided into sub-sections each under a supervisor, in order to more effectively control the progress of the fair-mapping through its successive stages.

22 new sheets of Bengal and 8 new sheets of Bihār and Orissa have been fair-mapped and submitted for publication during the year.

This section has also taken up the compilation and drawing of preliminary editions of quarter-inch sheets falling in its area and 2 sheets are in hand.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

66. Northern Circle. *No. 2 Party.*—A section of this party commenced the traverse survey of Allahābād City for detail survey on the scale 64 inches = 1 mile for the Allahābād Improvement Trust.

129 linear miles in an area of 4,128 acres were traversed and 78 plot charts prepared at a cost-rate of Rs. 61·5 per linear mile.

67. *Sind Sāgar Party.*—During the year under report, the party was employed on completion of the rectangulation of the Sind-Sāgar Doāb in connection with the Punjab Government Canal and Colonization project, in Miānwāli, Jhang and Muzaffargarh districts and in rectangulation in connection with the Sutlej valley project in Multān district.

Sub-division into 100-acre rectangles was carried out over the portion of the Sind-Sāgar Doāb, remaining over from previous years comprising an area of 740 square miles. 4,736 rectangles of 100 acres each were laid out and their corners marked by stones, making a final total of 50,774 100-acre rectangles over an area of 7,933·4 square miles for the whole project.

For the Sutlej valley project, sub-division into 25-acre rectangles was carried out in the Multān district in an area of 270·4 square miles. 6,922 rectangles of 25 acres each were laid out and their corners marked by stones. An area of 647·35 square miles was also triangulated for the purpose of laying down corners of 2,400-acre rectangles.

The country in the Sind-Sāgar Doāb which lies between the Indus and Jhelum and Chenāb rivers, locally known as the "Thal", is a vast tract of sand hills covered with stunted trees, sparsely populated and mostly waterless. Scattered patches of cultivation occur at rare intervals, surrounding wells, the water of which is brackish and almost undrinkable. The area of the Sutlej valley project is a flat plain, the portion bordering on the Sutlej river is thickly cultivated but, to the north, the plain is waterless and covered with dense jungle with occasional patches of sand.

In addition, a considerable amount of miscellaneous work in connection with the extension of rectangulation for the Sutlej valley project was carried out.

68. *No. 22 (Riverain) Party.*—The party continued the work of traversing and laying down base lines. 189 linear and 225 square miles of main circuits, and 3,373 linear and 526 square miles of minor traverse were executed, 323 theodolite stations of the former and 14,272 of the latter in 258 villages, were fixed. 363 corners of 121 squares in 375 square miles were demarcated with permanent mark-stones on both banks of the Sutlej river in Montgomery district and Bahāwalpur State, to serve as bases for future survey and demarcation of boundaries and fields in the bed of the river. 2,156 plotted and 649 boundary *masāvis* (settlement mapping sheets) on the scale of 1/2,640, and 37 four-inch sheets were traced and supplied in time to the Settlement Officers, Montgomery and Muzaffargarh. Besides these, 533 boundary *masāvis* were partly compiled on the scale of one inch = 220 feet for the next season's work, and 270 miscellaneous traces were prepared, all the traverse stations marked during the field season were plotted on 38 four-inch sheets.

The Lahore Town Traversing was undertaken at the request of the Sanitary Commissioner, Punjab for the large scale survey of Lahore and its environs for the purpose of sanitary improvement. It was commenced in the beginning of February 1921 and was finished in June 1921.

Three different scales *viz.*:—

(*i*) One inch = 100 feet for Lahore Town proper and the congested areas outside the old city walls,

(*ii*) Sixteen inches = 1 mile for the rest of the municipal area, and

(*iii*) Six inches = 1 mile for an area one and a half miles in breadth all round the municipal limit,

were proposed by the Sanitary Commissioner. Traverse lines had to be run with due regard to the scales. It was connected with points of the Gurhagarh Meridional Series, and with the Rāvi riverain traverse executed in seasons 1912—14. In all, 6,485 theodolite stations were laid down and 644 linear miles traversed, covering an area of about 63 square miles. 234 intersected points were also fixed. Inside the town the stations were marked with 9-inch long iron nails with round flat tops of 2-inch diameter and outside the town with stones 6 inches × 6 inches × 10 inches with ⊙ engraved into the top and embedded flush with the ground. All the traverse stations and intersected points were plotted on 8 × 8 inch sheets and 8 traces of the same were made.

Khaur Special Survey.—This was undertaken for the Attock Oil Company at their request through the Deputy Commissioner, Attock district. The work consisted in contouring at 10-feet intervals the area surveyed for them on scale 8 inches = 1 mile without contouring in season 1915-16 and surveying on the same scale, with contours at 10-feet interval, the adjacent area in the neighbourhood of Khaur village (Attock) and demarcation of the boundary of the new area for lease. The topography was based on traversing and levelling emanating from Khaur h.s. In all, 330 theodolite stations were laid out in 109·46 linear miles and 91 intersected points with heights were fixed. Level lines were run in suitable places to provide sufficient heights for the purpose of accurate contouring. In all, 43·05 linear miles were levelled and 1,235 stations were laid down and 80 bench-marks were fixed. The work was commenced in January and finished in March 1921. An area of 8 square miles was surveyed. 4 miscellaneous traces were prepared and all the traverse stations marked and intersected points were plotted on three 8-inch sheets.

Lahore "Nazul" *Land Survey,* on the scale of 1 inch = 40 feet, was undertaken at the request of the Deputy Commissioner, Lahore in connection with the Lahore city extension scheme. The survey was based on the traverse already done in connection with the Lahore town survey. It was commenced towards the end of August 1921. It is expected to be finished in October 1921. 33·5 acres have been surveyed.

69. Southern Circle.—The survey on the scale of one inch = fifty feet of 4 bāzārs areas within the limits of Bangalore Civil and Military Station is being carried out at the expense of the Bangalore Municipality, and the total area involved is 524 acres.

A considerable amount of traversing had to be carried out as only 10 per cent. of the old traverse stations could be found. The actual

amount of traversing carried out was 28·2 linear miles supplying 825 traverse stations, which works out at 1·6 stations per acre, the average distance between stations being 180 feet.

The number of sheets involved is 35 and the survey will be completed by the end of October 1921.

The cost-rates of this survey are shown on page 20.

At the request of the military authorities, an area of 1,121·3 acres of land adjoining Bangalore, required for a grass farm, has been surveyed on the sixteen-inch scale at a cost of Rs. 2,300.

70.—At the request of the Madras Government, Mr. J. O'B. Donaghey was placed on deputation for the settlement of the Mysore-South Kanara boundary. Representatives of the Madras Government and of the Mysore Durbar accompanied Mr. Donaghey and about 24 *miles* of some of the most difficult portions of the boundary were settled and a record prepared on prints of the Madras forest four-inch survey sheets. The work will be continued during the next field season.

71. Eastern Circle.—In addition to his duties in the Imperial Department, the Superintendent, as Director of Surveys, Assam held administrative charge of the Assam Survey Department, including the Assam Traverse Party, the Assam Drawing Office and Reproduction Office and the Assam Survey School; he also held administrative charge of the Maymyo Survey School under the Government of Burma.

72. No. 21 Party.—At the instance of the Government of Burma, the survey of a small length of boundary in the Southern Shan States was carried out by an officer in order to settle a dispute between two states.

73. Trigonometrical Survey.—At the request of the Punjab Government, levelling operations were carried out by No. 17 Party in Lahore City for the city sanitation scheme, (*vide* page 24). As this was a special work not properly belonging to the task of the Survey of India, its cost was defrayed by that Government.

74. Head Quarter Offices.—The total out-turn of all extra-departmental publications during the year for the Army, for Local Governments and for other government offices are given in Table A of the Photo.-Litho. Office report on page 35, in the "Issues" table and in Table IV of the Map Record and Issue Office report on pages 29 and 30.

In addition to the special maps for other departments which are mentioned in para. 51 (*g*) on page 28, these extra-departmental publications include various operation and manœuvre maps for the Army, maps to illustrate the journals of the United Service Institution, various reports of government officials, maps for railway guides, and for posting in railway carriages, &c. The usual large numbers of weather charts for the Meteorological Department and of the photogravure and half-tone illustrations for the Archæological and other departments were also printed.

The work entailed by the preparation of originals for some of these special maps, in addition to their publication, is mentioned in the reports of No. 1 Drawing Office and of the Engraving Office on pages 31 to 34.

75. Mathematical Instrument Office.—The manufacture and repair of heliographs, prismatic compasses, scales, protractors, &c., for military departments was carried on during the year. The manufacture and repair work for civil departments are now again well up to date.

76. No. 6 (Simla) Drawing Office.—In addition to its normal work for the Army, the *Army Section* has prepared maps and plans for the Legislative, Foreign and Political, and Commerce and Industries Departments.

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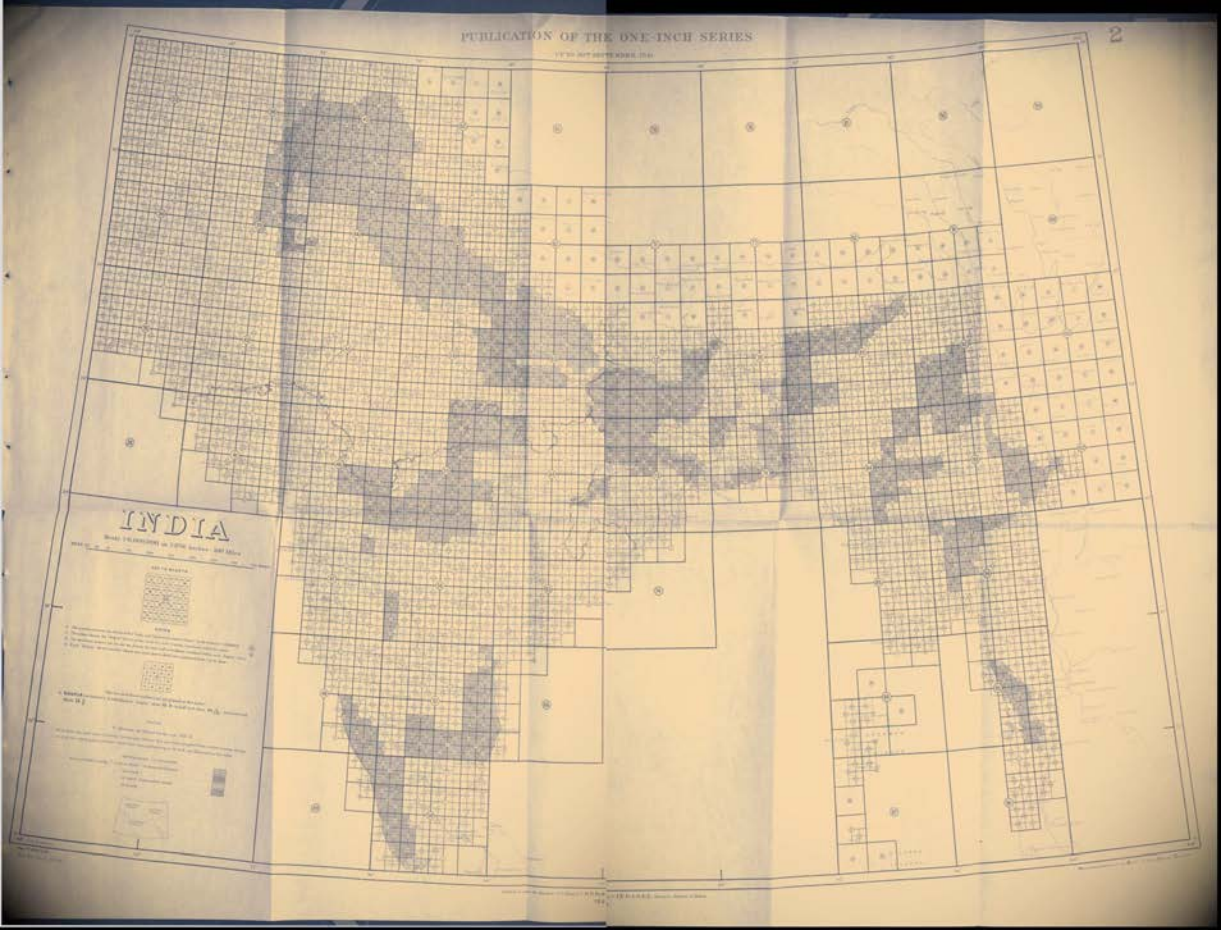
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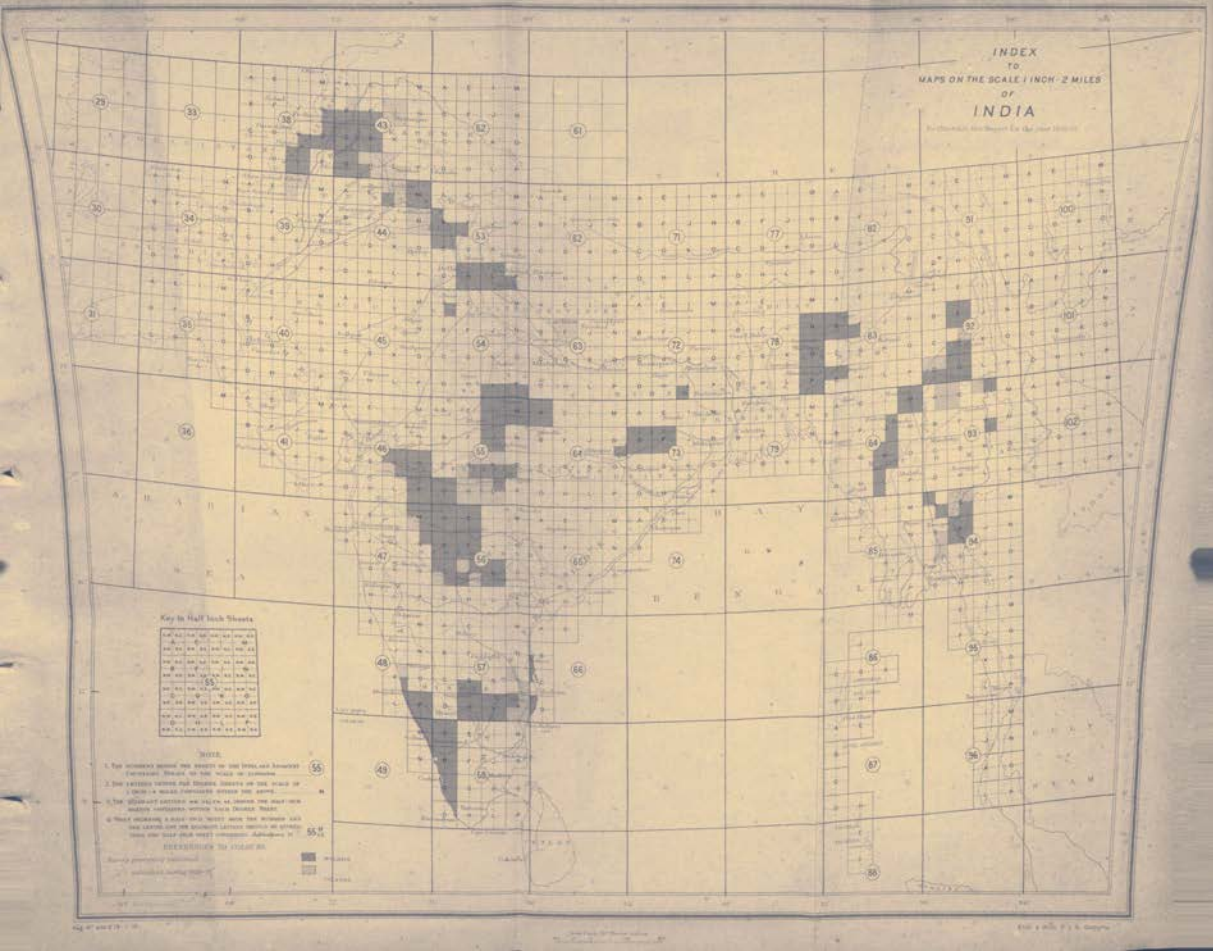
INDEX
TO
MAPS ON THE SCALE 1 INCH = 2 MILES
OF
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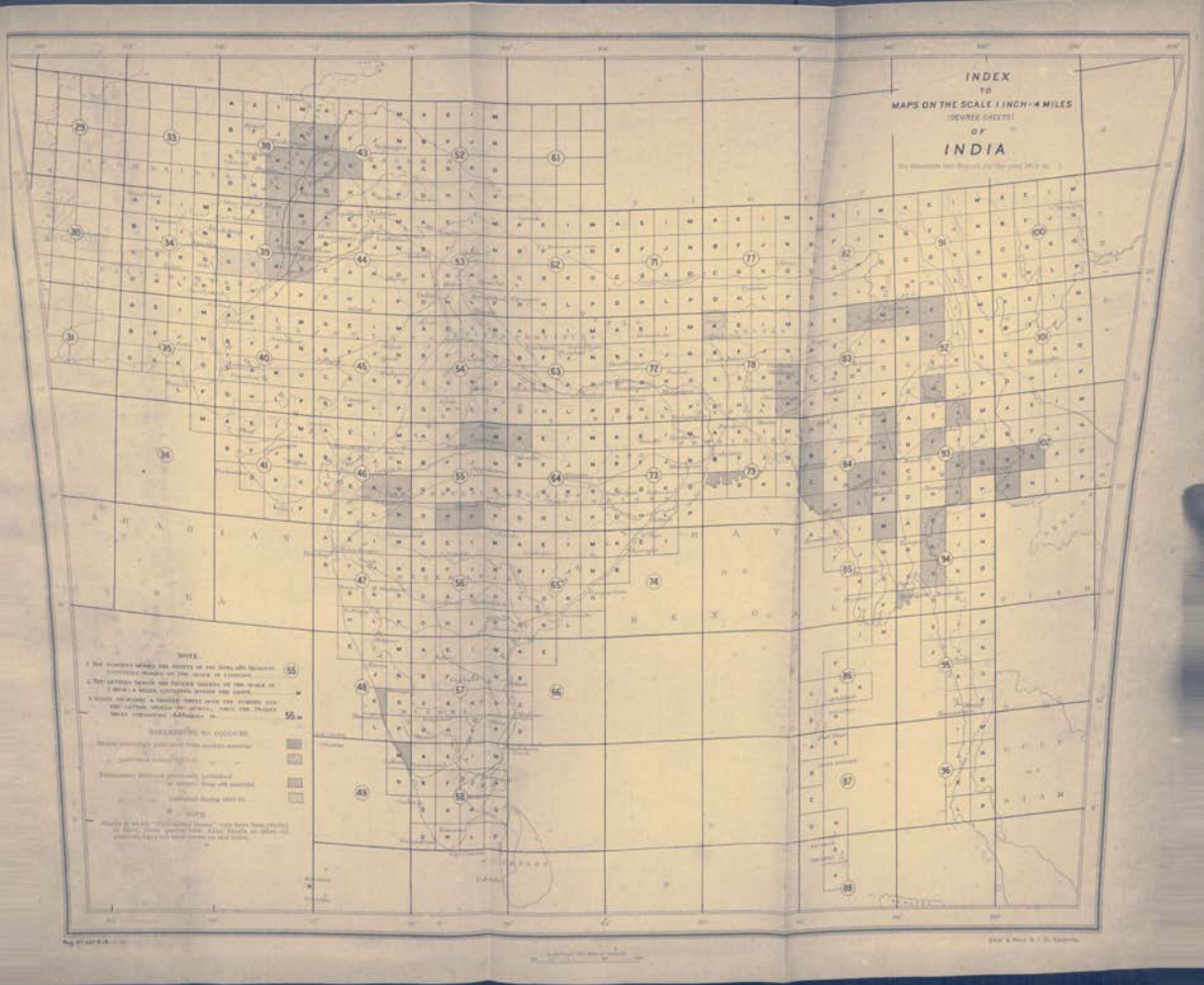
Key to Half Inch Sheets
NOTE.


INDEX
TO
MAPS ON THE SCALE 1 INCH = 4 MILES
(DEGREE SHEETS)
OF
INDIA
NOTE.
1. The numbers within the sheets of the 1000 mile Reference Diagram on the right or elsewhere.
2. The letters below the various sheets of the index of India's maps contained within the same.
3. Where necessary, a figure above the number and the letter below it, thus, 55/M, the Degree Sheet contained.
REFERENCE TO COLOURS.
Degree sheets published from standard material
Degree sheets published in colours from old material
Degree sheets published in black from old material
Degree sheets published during 1910-11.
NOTE.

4

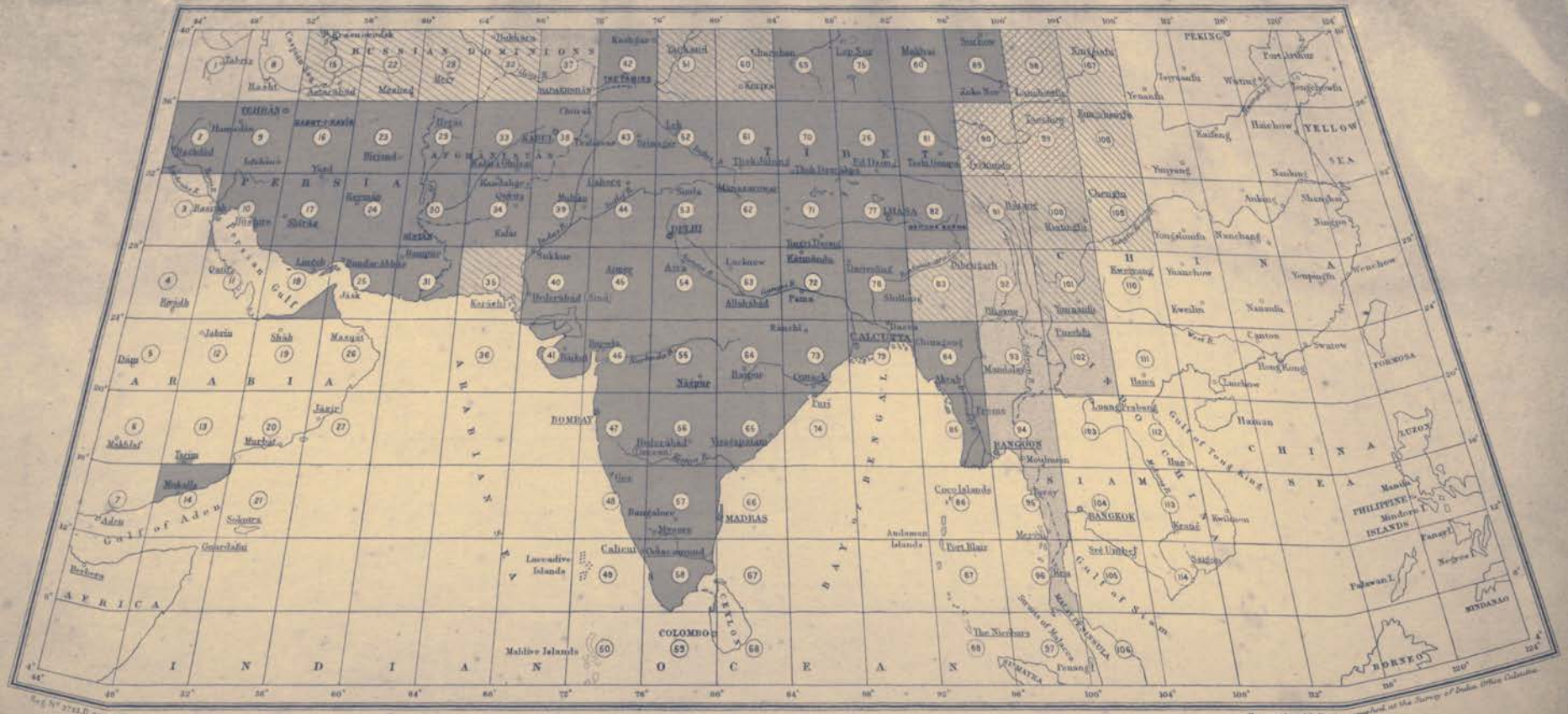
DEGREE SHEET SERIES

Scale 1 Inch to 4 Miles.

INDEX TO THE SHEETS OF THE

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1/1,000,000, or 1·014 inches to 16 miles.



Scale reduced.

Miles 200 0 100 200 300 400 500 Miles

NOTE.

The names underlined on this Index are the title names of the sheets, and their numbers are shown in circles. Sheets 35 and 36, 57 and 66, are published respectively as combined sheets.

REFERENCE

To illustrate the Report for the year 1921–22.

Sheets published without contours in brown.

" with contours in brown.

" in progress.

" not issued.

Engraved and lithographed at the Survey of India Office, Calcutta.

Rep. No. 3743, D. 20.-1000

5

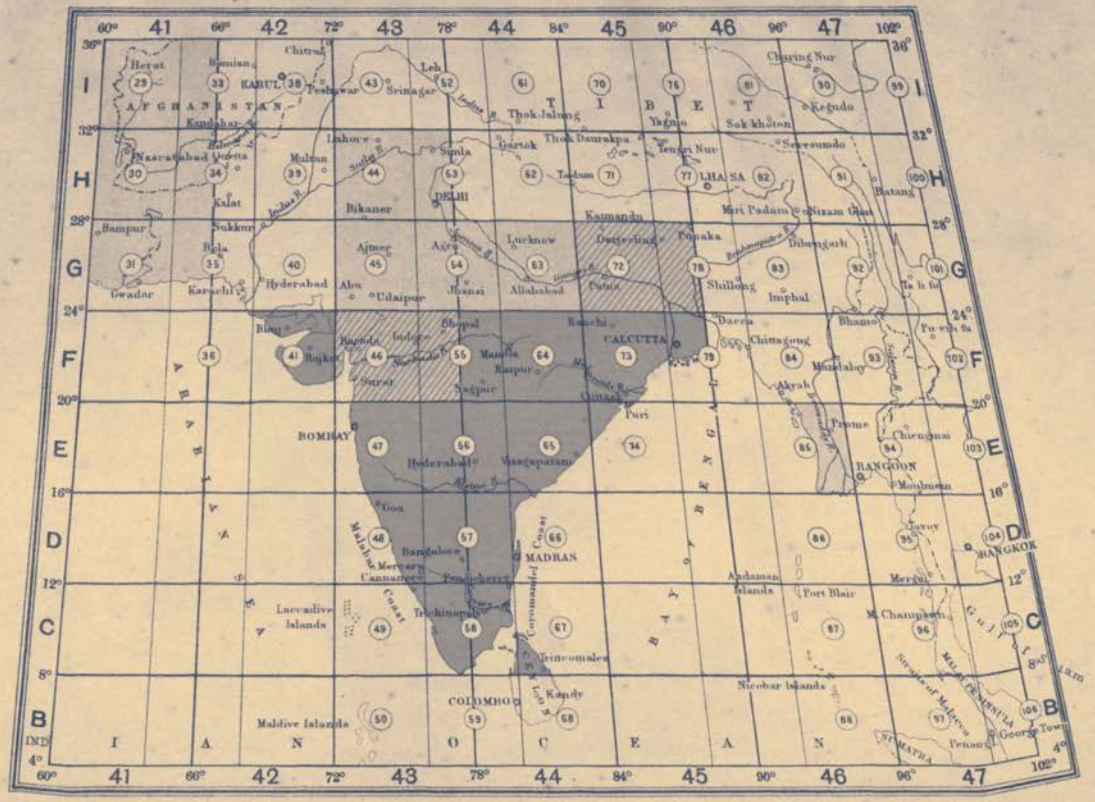
INDIA AND ADJACENT COUNTRIES SERIES

Scale 1: 1,000,000.

INDEX TO THE SHEETS OF THE

CARTE INTERNATIONALE DU MONDE

on the Scale of 1:1,000,000.



EXPLANATION.

The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter and number corresponding to its position, *e.g.*, the sheet which includes Bombay is N.E-43.

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.

Scale 32,000,000.

Miles 200 0 200 400 600 800 Miles

REFERENCE

Sheets published

" under publication

" in hand

To Illustrate the Report for the year 1920-21.

Reg. No. 3441 D., 16.1000

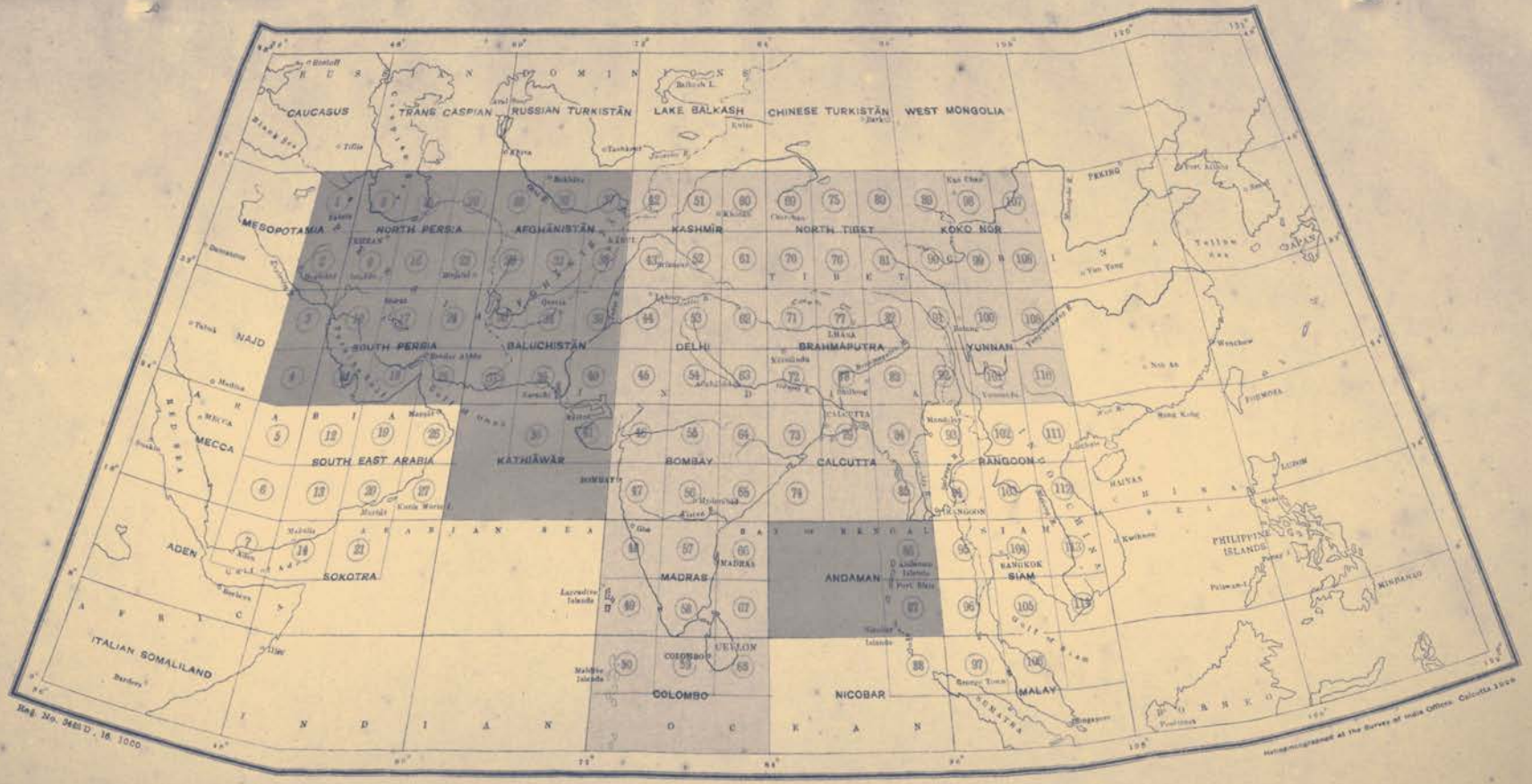
Helio., S. I. O., Calcutta.

INTERNATIONAL SERIES

Scale 1:1,000,000.

SOUTHERN ASIA SERIES

ON THE TWO MILLIONTH SCALE



Scale 1/40,000,000

Miles 200 0 200 400 600 800 1000 Miles

The E. portions of MESOPOTAMIA and NAJD sheets have been published for the present as outriggers to N. & S. PERSIA sheets respectively.

REFERENCE

To illustrate the Report for the year 1920-21

Sheets published with contours & layers

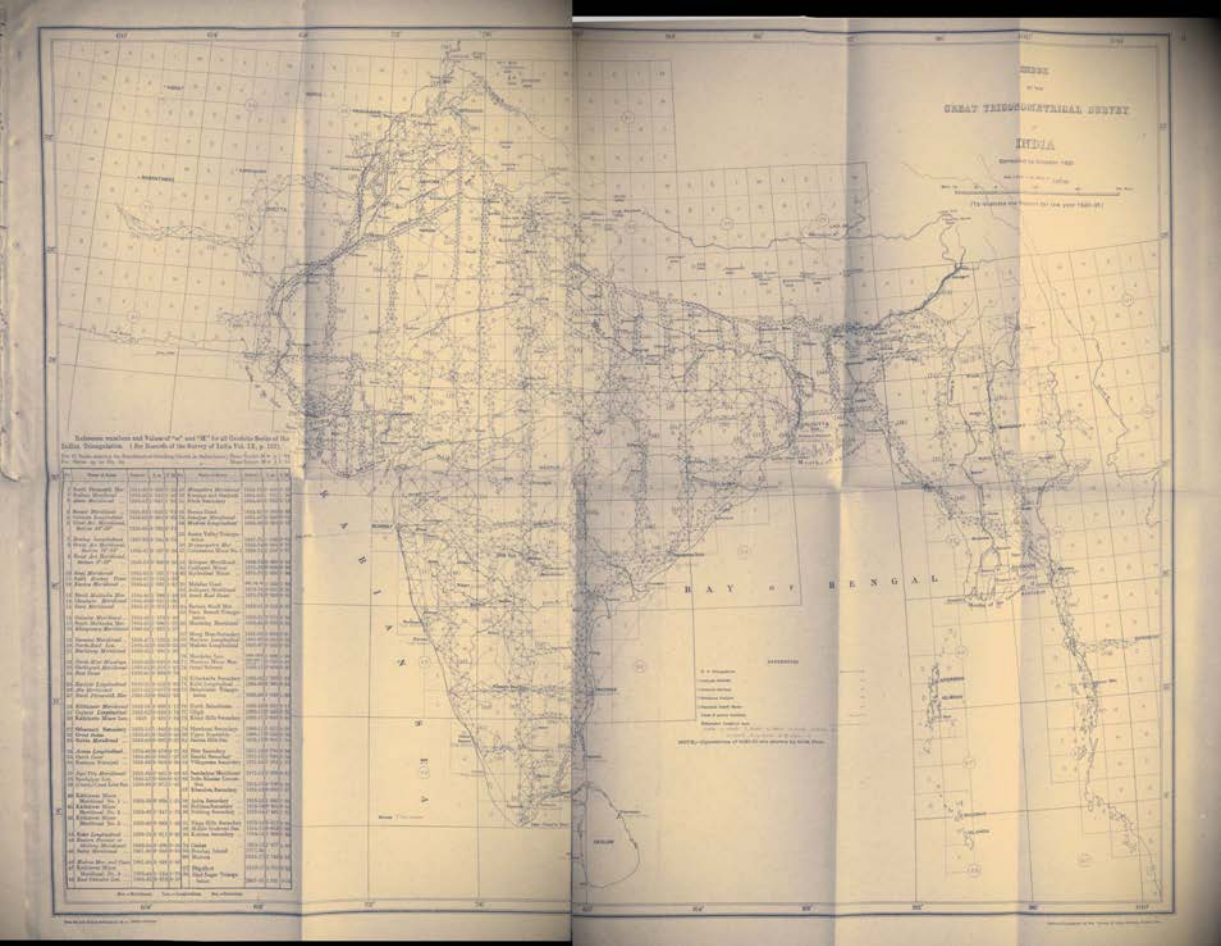
" under publication

" in hand

7

SOUTHERN ASIA SERIES

Scale 1:2,000,000.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to the
GREAT TRIGONOMETRICAL SURVEY
INDIA
(Triangulation completed to the year 1920-21)
BAY of BENGAL
ARABIAN SEA
CEYLON
Reference marks and Values of "m" and "M" for all Geodetic Series of the Indian Triangulation. (For Remarks on the Survey of India Vol. IX, p. 102).

Survey of India.

GENERAL REPORT,

1921–22.

From 1st October 1921
To 30th September 1922.

PREPARED UNDER THE DIRECTION OF

COLONEL C. H. D. RYDER, C.B., C.I.E., D.S.O., R.E.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1923.

Printed at the
Photographic and Lithographic Office, Survey of India,
14, Wood Street,
Calcutta.

NOTICE.

MAPS PUBLISHED BY THE SURVEY OF INDIA

are obtainable from the Map Record and Issue Office, 13, Wood Street, Calcutta, on the Public Service—on Cash Payment or Book-Transfer, and, for private use—on Cash Payment or V. P. P.

Forest maps are obtainable only from the Officer in charge, Forest Map Office, Dehra Dūn.

Geological maps are obtainable from the Director, Geological Survey of India, Calcutta.

The Survey of India publish maps for the greater part of SOUTHERN ASIA between the meridians of 44° and 124° East of Greenwich and between parallels 4° and 40° north latitude.

2. Surveys executed after 1905 are classed as "MODERN", those PRIOR to that date are classed as "OLD".

3. Maps are printed in two styles or editions *viz.*, LAYERED and POLITICAL:—

(*a*) The LAYERED edition represents a map printed in colours with graduated layer tints of colour to show altitudes, and, shading to emphasize the hills. This edition gives prominence to the physical features.

(*b*) The POLITICAL edition represents a map printed in colours, but without graduated layer tints. Hills are represented by contours and shading. This edition gives prominence to the Civil Divisions of India which are shown by ribands of colour along boundaries of administrative partitions.

NOTE.—When maps are printed in colours, from mixed or old surveys, the edition is styled "PRELIMINARY"; and when published in black only or with hills in brown, the edition is styled "PROVISIONAL" issue.

4. The series of Modern maps are grouped under three Divisions:—

(I) GEOGRAPHICAL, embracing—

(*a*) SOUTHERN ASIA SERIES, scale 1:2,000,000 or nearly 1 inch = 32 miles, in LAYERED and POLITICAL editions, size 36 inches × 24 inches, price Rs. 3 per copy.

(*b*) INDIA AND ADJACENT COUNTRIES; scale 1:1,000,000 or nearly 1 inch = 16 miles, in LAYERED and POLITICAL editions, or if from old surveys, as PRELIMINARY editions; size 24 inches × 19 inches, price Re. 1-8 per copy. If printed on linen-backed paper Rs. 2-4.

(*c*) INTERNATIONAL MAP OF INDIA, scale 1:1,000,000 or nearly 1 inch = 16 miles, in LAYERED edition (without shading of hills), size 30 inches × 26 inches, price Re. 1-0 per copy.

(II) TOPOGRAPHICAL, comprising maps on:—

(*a*) SCALE 1 INCH = 1 MILE, in the POLITICAL edition, size 24 × 19 inches, price Re. 1-8 per copy.

(*b*) SCALE 1 INCH = 2 MILES, in the POLITICAL edition, size 24 × 19 inches, price Rs. 3-0 per copy.

(*c*) SCALE 1 INCH = 4 MILES, in the LAYERED and POLITICAL editions, size 24 × 19 inches, price Re. 1-8 per copy, and from old surveys as PROVISIONAL issues, price Re. 1 per copy.

NOTE.—Modern Topographical maps printed on linen-backed paper are As. 12 extra per copy. Index charts or Key maps to the Geographical and Topographical series are obtainable gratis.

(III) GENERAL MAPS which include:—

(*a*) GENERAL MAPS OF INDIA, scale 1 inch = 32 miles, in sets of 12 sheets, each sheet 25 × 32 inches, in LAYERED and POLITICAL editions, price Rs. 12 per set, and on scale 1 inch = 64 miles, POLITICAL edition only, size about 3½ feet square, at Rs. 6 the copy. Also various maps of India on the same and smaller scales and miscellaneous special maps illustrating Railways, &c.

(*b*) PROVINCIAL MAPS, on scales 1 inch = 16 miles and 1 inch = 32 miles.

(*c*) DISTRICT MAPS, on scales 1 inch = 4 miles and 1 inch = 8 miles.

(*d*) CANTONMENT AND TOWN MAPS AND OTHER MISCELLANEOUS MAPS, of various scales and prices.

5. MAP CATALOGUES can be obtained at ONE RUPEE per copy.

6. Maps can be mounted on cloth and folded or mounted on rollers for hanging, &c., at an extra charge.

7. For particular purposes, copies of any map can be supplied in black or black and brown on request and at special rates.

8. Any map, chart or diagram can be reproduced if the applicant submits a suitable original drawing. Special rates exist for such work and estimates can be given on request.

9. The prices quoted for various maps are exclusive of postage and V. P. P. charges. Any further information may be obtained free of charge from the Officer in charge, Map Record and Issue Office, 13, Wood Street, Calcutta.

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3. ,, modern half-inch series for India.
4. ,, ,, quarter-inch ,, ,,
5. ,, 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
6. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
7. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
8. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1921—22.

From 1st October 1921
To 30th September 1922.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shown in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XVIII of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 44,604* square miles; and that this brings the total progress since 1905 to 625,339 square miles, leaving 1,196,261 square miles still to be done.

3. The first Index map, at the end of the report, shows the progress of this topographical programme both in survey and in publication in the three circles, while the remaining seven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the survey of India is based.

4. Table IV on page 31 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations

---

*Excludes 37 square miles surveyed on half-inch scale in 1920-21 and re-surveyed on one-inch scale in 1921-22, 9 square miles of eight-inch survey, and 365 square miles previously surveyed on the 1¼-inch scale.

6. The following events are notified:—

(*a*) A fair progress was made this year in the topographical surveys of this department, the area surveyed this year exceeding that of the previous year by 4,643 (44,604—39,961) square miles. Only one topographical party which had been in the field during the whole of the previous year remained in recess for the current year. It is hoped that with the existing strength the prewar average of over 50,000 square miles will be attained in the near future. The field work of the Trigonometrical Survey had to be considerably curtailed owing to financial reasons.

(*b*) Messrs. Sher Jang, K.B., Sub-Assistant Superintendent, and Lal Singh, R.B., Sub-Assistant Superintendent (retired) were presented to H. R. H. the Prince of Wales during his visit to Dehra Dūn on the 13th March 1922.

(*c*) Major H. T. Morshead, D.S.O., R.E., was permitted, while on leave, to accompany the Mount Everest Expedition of 1922.

(*d*) Captain H. R. C. Meade, I.A., and Mr. Bansi Ram, Sub-Assistant Superintendent, accompanied the Political Officer, Sikkim, on a journey to Bhutān.

(*e*) A Survey detachment has been formed from the 18th October 1921 for the purpose of carrying out traverse survey in the Bhopāl State.

(*f*) Officers were deputed in connection with the settlement of boundaries, *e.g.*, Mysore-South Kanara, Assam-Burma, United Provinces-Benares State.

(*g*) A surveyor was deputed to Tibet with Sir H. H. Hayden.

(*h*) During the solar eclipse in September 1922, observations were carried out with a view to determine whether the elements of the earth's magnetism underwent change during the obscuring of the sun.

(*i*) Lieut.-Colonel G. A. Beazeley, D.S.O., R.E., taught his system of air sketching to military officers at Risalpur. He also instructed officers of the Iraq administration in air-reconnaissance and sketching.

(*j*) Lectures on maps and surveys were delivered by Lieut.-Colonel C. P. Gunter, O.B.E., R.E., to Intelligence Classes at Poona and Bangalore.

(*k*) A permanent executive charge was sanctioned for the Map Record and Issue Office with effect from the 11th September 1922; the number of executive charges reserved for Class II officers was thus raised from 10 to 11 (3 of which are temporary for the present).

(*l*) There has been an increased demand both from the public and Government officials for maps during the year.

A branch office for the convenience of the Calcutta public has been temporarily established in No. 5, Esplanade East, for the display and sale of departmental publications.

(*m*) The demand for large scale surveys of towns, &c., is continuous.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1922 and of the two previous years is shown below:—

	1919-20.	1920-21.	1921-22.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	44,92,352	48,70,530	**51,48,926***	* These figures are not final.
Deduct receipts and credits	20,65,422	15,52,147	**17,86,351***	
Net actual charges ...	24,26,930	33,18,383	**33,62,575***	

8. Colonel C. H. D. Ryder, C.B., C.I.E., D.S.O., R.E., administered the department throughout the year.

9. Of Class I officers:—Bt.-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., retired, the services of Colonel H. H. Turner, R.E., were replaced at the disposal of His Excellency the Commander-in-Chief in India, and Major O. H. B. Trenchard, R.E., reverted to the Home Establishment.

Major V. R. Cotter, I.A., reverted from deputation to military duty.

Mr. M. C. Petters was on deputation in connection with the settlement of United Provinces—Benares boundary from 14th to 24th March 1922. Mr. J. O'B. Donaghey was on deputation under the Government of Madras for about 2½ months. Captain H. R. C. Meade, I.A., was on deputation to accompany the Political Officer, Sikkim, on his journey through Bhutān for about 4½ months.

Lieutenants G. H. Osmaston, M.C., R.E., G. F. Heaney, R.E., and G. Bomford, R.E., have been deputed temporarily to military duty, England, to attend the Supplementary Course for R. E. officers at Chatham.

Mr. Jagdamba Prasad, R.B., was promoted temporarily from the Class II Service.

Of Class II officers:—Mr. E. G. Hardinge was placed on deputation under the Government of Assam to take over charge of duties from Mr. A. B. Smart who finally retired on the termination of his re-employment. Mr. F. C. Saint was dismissed, Mr. J. A. Calvert resigned.

Mr. W. J. Baker who had been on deputation to Burma retired on 4th September 1921. Mr. C. J. Veale was permanently transferred under the Government of the United Provinces.

Mr. V. W. Morton was on deputation under the Government of Madras for about 4 months and to military duty with the Auxiliary Force, India, for about a month.

Mr. J. C. St. C. Pollett was on deputation to military duty with the Auxiliary Force, India, for about a month.

Messrs. S. R. Kelkar, B.Sc., Muhammad Aslam Chowdhury, B.A., and C. P. E. Davenport were appointed during the year.

In the Upper Subordinate Service, Messrs. Dharmu, Dalbir Rai and Masud Khan retired, Mr. Amulya Charan Ghosh resigned, Mr. Kunja Behari Lal died, Mr. Gulab Singh has been reverted to the Lower Subordinate Service. 3 officers were promoted from the Lower Subordinate Service and 10 candidates were appointed on probation, 5 of whom resigned.

Mr. Bansi Ram was on deputation to the Assam-Burma boundary survey for three months and with the detachment formed to accompany the Political Officer, Sikkim, on his journey through Bhutān for about 4 months.

The total strength of the department at the close of the Survey year was 60* Class I officers, 96† Class II officers and 82‡ Upper Subordinates, besides specialists, clerks, lower subordinates and menials.

10. On completion of its programme in the Southern Command, No. 20 (Cantonment) Party has been placed under the administrative control of the Superintendent, Northern Circle, from the 1st April 1922.

11. The following honours and rewards were conferred during the year:—

Companion of the Order of the Bath.—	Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E.,
Officer of the Order of the British Empire.—	Mr. P. A. T. Kenny, M.B.E., Extra Assistant Superintendent.
Members of the Order of the British Empire.—	,, L. Williams, Extra Assistant Superintendent.
	,, G. A. Norman, Extra Assistant Superintendent.
	,, A. J. Booth, Extra Assistant Superintendent.
Rai Bahadur.—	,, Jagdamba Prasad, R.S., Deputy Superintendent (Temporary).
Rai Sahib.—	,, Hunuman Prasad, Extra Assistant Superintendent.
	,, Dhani Ram Verma, Extra Assistant Superintendent.
	,, Shib Lal, Sub-Assistant Superintendent.
Khan Sahib.—	,, Afraz Gul Khan, Sub-Assistant Superintendent.

Mr. Ram Prasad, R.S., Sub-Assistant Superintendent, was awarded an honorarium of Rs. 500 for skillful withdrawal of his men from the west of the Hukawng valley during Nāgā raids.

Mr. V. W. Morton, Extra Assistant Superintendent, has been granted a commission in the Auxiliary Force, India, as Lieutenant in No. 14 Battery, Royal Field and Garrison Artillery.

Mr. B. T. Wyatt, Extra Assistant Superintendent, (Bangalore Battalion), has been granted a commission as Second-Lieutenant in the Auxiliary Force.

Second-Lieutenant J. C. St. C. Pollett, Extra Assistant Superintendent, has been promoted to the rank of Lieutenant in the Auxiliary Force.

Of the 18 members of the Mussoorie Battalion of the Auxiliary Force which won the Reading Cup for shooting this year, the following seven were officers of the Survey of India:—Messrs. E. B. West, O. N. Pushong, Major C. H. Tresham, Messrs. L. Williams, A. A. Graham, C. O. Picard and H. T. Hughes, Extra Assistant Superintendents.

12. The following table shows the distribution of officers during the year. The names of officers on leave, on deputation to Local Governments, on military duty followed by leave or on foreign service throughout the year are omitted.

---

* Including one officer temporarily promoted from the Class II Service.

† Including officers on foreign service and probationers but excluding one officer temporarily promoted to Class I Service, one officer re-employed and officers on deputation to Local Governments (except Mr. P. Simpson on deputation to Bihār and Orissa).

‡ Including probationers and one officer on foreign service.

TABLE I—DISPOSITION OF OFFICERS, 1921-22.

SURVEYOR GENERAL OF INDIA—Colonel C. H. D. Ryder, C.B., C.I.E., D.S.O., R.E.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Lt.-Col. R. H. Thomas, D.S.O., R.E. Major H. J. Couchman, D.S.O., M.C., R.E.			

SUPERINTENDENT, MAP PUBLICATION—

Lieut.-Colonel G. A. Beazeley, D.S.O., R.E., up to 31st October 1921.
Brevet-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., from 1st November 1921 to 22nd March 1922.
Lieut.-Colonel E. A. Tandy, R.E., from 23rd March to 15th June 1922.
" E. T. Rich, C.I.E., R.E., from 16th June 1922.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.	.....	Mr. J. Prasad, R.B. " Pramadaranjan Ray, R.S.		
No. 1 Drawing Office, Map Record and Issue Office, & Engraving Office, Calcutta.	Major F. F. Hunter, D.S.O., I.A. " V. R. Cotter, I.A. Mr. J. Prasad, R.B.	Mr. P. Williams " Pramadaranjan Ray, R.S. " Abinash Chunder Bose " C. West " A. B. Hunter " Priya Nath Sur " F. B. Kitchen " Munshi Lal, B.A. " H. T. Hughes " P. C. Mitra, B.A. " Jiya Lal Sahgal		
Photo.-Litho. Office, Calcutta.	Lt.-Colonel A. A. McHarg, D.S.O., R.E. Major F. J. M. King, R.E.			
Mathl. Instt. Office, Calcutta.	Mr. T. A. Ferrier, C.B.E.			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).	.....	Mr. C. West.....	Mr. Charu Chandra Biswas.	
No. 6 Drawing Office (Simla).	Major L. G. Crosthwait, I.A. ...	Mr. R. E. M. Saubolle ..... Mr. Sher Jang, K.B. ..... " H. H. P. Butterfield		5 European Draftsmen. 4 Printers. 2 Clerks. 17 Indian Draftsmen.

SUPERINTENDENT, NORTHERN CIRCLE —Lieut.-Colonel H. Wood, R.E.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.	Mr. J. A. Freeman	Mr. E. B. West ..... " A. A. Graham " Moqimuddin " H. G. Shaw (re-employed).	.....	43 Surveyors, &c.
No. 1 Party,..... *Punjab, Punjab States, United Provinces.*	Lt. G. H. Osmaston, M.C., R.E. (*on probation*). " G. F. Heaney, R.E. (*on probation*).	Mr. C. C. Byrne ..... " P. A. T. Kenny, O.B.E. " A. M. Talati, L.C.E. Major C. H. Tresham Mr. R. C. Hanson " A. J. A. Drake, D.C.M. " H. T. Hughes " O. D. Jackson	Mr. Sher Jang, K.B. ..... " Muhammad Husain Khan, K.S. " Afraz Gul Khan, K.S. " Muhammad Khan " Muhammad Hasan " Jit Singh Rawat " Sijawal Khan " Latif Khan " Mohammad Jamsed (*on probn.*) " Mohammad Abdus Sattar (*on probation*).	30 Surveyors, &c.
No. 2 Party,..... *Central India, Rājputāna and United Provinces and Delhi Province.*	Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E. Capt. L. H. Jackson, I.A. " W. J. Norman, M.C., R.E. (*on probation*). " T. W. R. Haycraft, R.E. (*on probation*). Lt. G. H. Osmaston, M.C., R.E. (*on probation*). " G. F. Heaney, R.E. (*on probation*).	Mr. J. McCraken, M.B.E. ... " C. O. Picard " Duni Chand Puri " Prafulla Kumar Ghosh, B.Sc. (*on probation*).	Mr. Muhammad Husain Khan, K.S. " Muhammad Husain " Imam Din " Afraz Gul Khan, K.S. " Jagannath " Narsingh Das Joshi " Mohammad Jamsed (*on probation*). " Mohammad Abdus Sattar (*on probation*).	57 Surveyors, &c.
No. 3 Party,..... *United Provinces and Nepāl.*	Major C. G. Lewis, R.E. ..... Captain L. H. Jackson, I.A. " T. W. R. Haycraft, R.E. (*on probation*).	Captain J. H. Williams ..... Mr. E. B. West " L. Williams, M.B.E. " J. H. Johnson " A. J. A. Drake, D.C.M.	....	38 Surveyors, &c.
No. 4 Party,..... *United Provinces.*	Mr. M. C. Petters	Mr. G. A. Norman, M.B.E. " F. C. Saint (dismissed from 1-8-22), " Moqimuddin	Mr. Chuni Lal Kapur ..... " Lakshmi Dutt Joshi " Vidya Dhar Chopra " Laltan Khan, I.D.S.M. " Mohabat Lal Kohli (*on probn.*) " Narayana Chandra Ray, (*on probation*). " Dalip Singh Gandhi (*on probn.*)	36 Surveyors, &c.
No. 20 Party,..... *Cantonments and Military District Lands in the 5th, 6th and 9th Divisions.*	Captain J. K. Douglas, R.E. ...	Mr. J. H. S. Wilson ..... " C. E. C. French " F. W. Smith	Mr. Dharmu (retired from 1-7-22). " J. M. Mukerji	28 Surveyors, &c.
No. 22 Party,..... *Punjab.*	Mr. H. H. B. Hanby.....	Mr. Dhani Ram Verma, R.S.	Mr. Jamna Prasad, R.S. ..... " Ram Narayan Hastir " Gulab Singh, (reverted to L. S. S. from 23-9-22) (*a*)	33 Traversers, &c. (*c*)
No. 23 (Punjab Rectangulation) (old Sind-Sāgar) Party, *Punjab.*	Major R. Foster, I.A.	Mr. J. C. C. Lears ..... " C. O. Picard " D. N. Banerjee, L.C.E.	Mr. Lakshmi Dutt Joshi ..... " Amrit Ram (*b*)	17 Surveyors, &c. (*d*)
Bhopāl Traverse Detachment.	.....	Mr. Maya Das Puri, R.S. ...	Mr. Nabidad Khan	5 Traversers, &c. (*e*)

(*a*) Excluding 1 Supervisor on the purely temporary establishment.
(*b*) Excluding 2 Supervisors on the purely temporary establishment.
(*c*) Excluding 22 purely temporary men.
(*d*) Excluding 76 purely temporary men.
(*e*) Excluding 11 purely temporary men.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1921-22.

SUPERINTENDENT, SOUTHERN CIRCLE

Colonel H. H. Turner, R.E., up to 17th April 1922.
Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 18th April to 29th May 1922.
Colonel H. H. Turner, R.E., from 30th May to 9th August 1922.
Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 10th August 1922.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.	Mr. J. H. Nichol „ J. O'B. Donaghey	Mr. E. Claudius	Mr. B. V. Narayana Rao „ Damodar Khadilkar „ V. R. Ethirajulu Nayadu	43 Draftsmen, &c.
No. 5 Party, *Gwalior, Central India and Central Provinces.*	Major F. B. Scott, I.A. Captain G. Lennox, I.A.	Mr. J. H. S. Wilson „ F. C. Pilcher „ F. W. Smith „ J. A. Calvert, (resigned from 12-1-22). „ Mahammad Najamuddin, B.A. *(on probation).*	Mr. P. S. Vengusvami „ Daulat Ram Vohra „ J. A. Cabral „ Mauji Ram Sharma *(on probation).*	37 Surveyors, &c.
No. 6 Party, *Hyderābād.*	Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Captain J. K. Douglas, R.E. *(on probation).*	Mr. H. B. Simons „ E. A. Meyer „ J. C. St. C. Pollett „ E. N. Natesan, B.A.	Mr. K. G. Mandanna „ Daulat Ram Vohra „ T. S. Narayanan, B.A. *(on probation).*	26 Surveyors, &c.
No. 7 Party, *Madras and Hyderābād.*	Major J. D. Campbell, D.S.O., R.E. Captain G. W. Gemmell, I.A. *(on probation).* Lieut. G. Bomford, R.E. *(on probation).*	Mr. F. H. Grant „ A. F. Murphy „ N. S. Harihara Iyer „ T. O. Threlfall *(on probation)*	Mr. K. Narayanaswami Chetti „ Shib Lal, R.S. „ Shadi Lal Dube „ K. B. Muthanna *(on probation).*	39 Surveyors, &c.
No. 8 Party, *Madras and Bombay.*	Lieut.-Colonel M. O'C. Tandy, D.S.O., O.B.E., R.E. Captain J. K. Douglas, R.E. *(on probation).*	Mr. M. Mahadeva Mudaliar, M.A. „ B. T. Wyatt „ M. S. Ganesa Aiyar	Mr. H. Narasimhamurti Rao „ Shaikh Muhammad Salik „ Abdul Ghafur „ Janam Raj Chibbar *(on probation).*	42 Surveyors, &c.
Training Section ...		Mr. S. S. McA'F. Fielding „ V. W. Morton	14 Probationers	23 Surveyors and Pupils.
Record Section		Mr. Haji Abdul Rahim, K.B.	Mr. Annada Prasad Ghosh ...	5 Computers, &c.

SUPERINTENDENT, EASTERN CIRCLE } Colonel W. M. Coldstream, R.E.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	Captain H. R. C. Meade, I.A. *(on probation).*		Mr. Bhamba Ram	
No. 5 Drawing Office, Shillong.	Mr. W. M. Gorman	Mr. E. G. Hardinge (on deputation, Assam, from 12-9-22).	Mr. Jagdeesh Prasad Vastav ... „ Bansi Ram	28 Surveyors, &c.
No. 9 Party, *Bengal and Bihār and Orissa.*	Bt.-Lieut.-Colonel R. H. Phillimore, D.S.O., R.E. Captain R. S. P. MacIvor, I.A. *(on probation).* Lieut. H. A. Bazley, R.E. *(on probation).*	Mr. E. J. Biggie „ Amar Krishna Mitra Lieut. C. S. McInnes. Captain J. O'C. Fitzpatrick Mr. Bhupendra Nath Saha, M.Sc. *(on probation).*	Mr. Jagdeesh Prasad Vastav ... „ Gopal Lal Mitra „ Sasadhar Mukerjee „ Rohini Kumar Talapatra, B.A. *(on probation).*	37 Surveyors, &c.
No. 10 Party, *Upper Burma.*	Lieut.-Colonel E. T. Rich, C.I.E., R.E. Captain O. Slater, M.C., R.E. *(on probation).*	Mr. W. G. Jarbo „ S. F. Norman „ O. J. H. Hart „ F. J. Irice „ H. H. Creed	Mr. Hayat Muhammad, K.S. „ Dhirendra Nath Saha „ Ram Prasad, R.S. Maung Pe, A.T.M.	26 Surveyors, &c.
No. 11 Party, *Lower Burma.*	Mr. J. O. Greiff Captain T. M. M. Penney, R.E. *(on probation).*	Mr. O. J. H. Hart „ G. E. R. Cooper „ A. V. Dickson	Mr. Pratul Chandra Sen Gupta, B.Sc. „ Khan Muhammad „ Abani Kumar Sen Gupta *(on probation).*	24 Surveyors, &c.
No. 12 Party, *Assam.*	Bt.-Lieut.-Col. C. M. Browne, C.M.G., D.S.O., R.E.	Mr. E. M. Kenny „ D. K. Rennick, M.B.E. „ R. C. Hanson „ Prafulla Chandra Mitra, B.A.	Mr. Girija Sonker Bagchi „ Atul Chandra Maulick *(on probation).* „ Suresh Chandra Chatterjee, B.Sc. *(on probation).*	38 Surveyors, &c.
No. 21 (Burma Forest) Party, *Upper and Lower Burma.*	Mr. H. W. Biggie	Mr. S. F. Norman Lieut. L. B. Fitz-Gibbon Captain V. P. Wainright C. B. Sexton Mr. H. M. Critchell *(on probation).*	Mr. Dalbir Rai (retired from 1-7-22). „ Ghulam Hasan	20 Surveyor, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1921-22.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY

Lieut.-Colonel H. McC. Cowie, R.E., up to 17th October 1921.
" " E. A. Tandy, R.E., from 18th October 1921 to 10th March 1922.
" " H. McC. Cowie, R.E., from 11th March to 2nd July 1922.
Major L. C. Thuillier, I.A., from 3rd July to 2nd August 1922.
Lieut.-Colonel H. McC. Cowie, R.E., from 3rd August 1922.

	Class I Officers.	*Class II Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	Lieut.-Colonel R. H. Thomas, D.S.O., R.E. Major W. E. Perry, M.C., R.E. *(On probation).* Captain H. R. C. Meade, I.A. " R. S. P. MacIvor, I.A. Lieut. G. H. Osmaston, M.C., R.E. " H. A. Bazley, R.E. " G. F. Heaney, R.E. " G. Bomford, R.E. Captain G. W. Gemmell, I.A.	Mr. Nanak Chand Puri, B.A., R.S. *(Probationers).* " Srinivasa Rao Kelkar, B.Sc. " Muhammad Aslam Chowdhury, B.A. " C. P. E. Davenport.	Mr. Lalbir Singh.	
Computing Office.	Dr. J. deGraaff Hunter, M.A., Sc.D., F. Inst. P. Major C. M. Thompson, I.A. Captain E. A. Glennie, D.S.O., R.E.	Mr. Hanuman Prasad, R.S.	Mr. Sarat Kumar Mukerji	64 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major L. C. Thuillier, I.A. " F. J. M. King, R.E. " W. E. Perry, M.C., R.E. Captain R. S. P. MacIvor, I.A.	Mr. H. P. D. Morton ..... " H. B. Simons " Rama Prasad Ray, B.A. " T. F. Kitchen " O. D. Jackson " Nanak Chand Puri, B.A., R.S. " Asmat-ullah Khan, K.B.	Mr. Ram Singh, R.S..... " Paras Ram " Jugal Behari Lal " Baldeo Bihari Lal " Kunja Behari Lal (died on 3rd May 1922). " Sadik Ali " Muhammad Hasan	169 Draftsmen, &c.
No. 13 Party, *(Astronomical).*	Captain H. E. Roome, M.C., R.E.	.....	.....	2 Computers, &c.
No. 14 Party, *(Pendulum).*	Lieut.-Colonel H. McC. Cowie, R.E. Major W. E. Perry, M.C., R.E.	.....	.....	2 Computers, &c.
No. 15 Party, *(Triangulation).*	Major H. T. Morshead, D.S.O., R.E. Mr. E. C. J. Bond, V.D. Bt.-Major K. Mason, M.C., R.E. " " E. O. Wheeler, M.C., R.E. Captain E. A. Glennie, D.S.O., R.E.	.....	Mr. Muhammad Hasan	6 Computers, &c.
No. 16 Party, *(Tidal).*	Major C. M. Thompson, I.A. Captain E. A. Glennie, D.S.O., R.E.	Mr. Hanuman Prasad, R.S. " D. H. Luxa	.....	21 Computers, &c.
No. 17 Party, *(Levelling).*	Major F. J. M. King, R.E. Bt.-Major K. Mason, M.C., R.E. Captain E. A. Glennie, D.S.O., R.E.	Mr. G. J. S. Rae ..... " O. N. Pushong " Raj Bahadur Mathur, B.A. " K. S. Gopalachari, B.A. " Narendra Nath Chuckerbutty, L.C.E.	Mr. Karuna Kumar Das, B.A. " Satish Chandra Mukerjee " Pulin Behari Roy " Amir Abdul Salam Matlub Ahmad " Abdul Majid	16 Computers, &c.
No. 18 Party, *(Magnetic).*	Mr. E. C. J. Bond, V.D.	Mr. Nikunjo Ronjon Mazumdar " Jiya Lal Sahgal	Mr. Bidhu Bhusan Shome " Hem Chandra Banerjee, B.A.	1 Magnetic Observer. 10 Computers, &c.
No. 19 Party, *(Base Line).*	Major V. R. Cotter, I.A. Captain E. A. Glennie, D.S.O., R.E.	.....	.....	1 Clerk, &c.

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

13. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905 and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shown in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 557,000 square miles are likely to be surveyed on the half-inch or smaller scales.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052*	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
1917-18 ...	ditto ...	4,202	12,181	8,396	24,779
1918-19 ...	ditto ...	509	7,263	6,176	13,948
1919-20 ...	ditto ...	9,145	11,891	9,428	30,464
1920-21 ...	ditto ...	14,411	14,275	11,275	39,961
1921-22 ...	ditto ...	11,528*	21,596†	11,480	44,604
Total areas completed to date ...		**247,394**	**210,192**	**167,753**	**625,339**
Approximate areas for the whole topographical programme.		**750,000**	**542,800**	**528,800**	**1,821,600**
Approximate areas remaining for survey.		**502,606**	**332,608**	**361,047**	**1,196,261**

* Excludes 37 square miles surveyed on half-inch scale in 1920-21 and re-surveyed on one-inch scale in 1921-22, and 9 square miles of eight-inch survey.

† Excludes 365 square miles previously surveyed on the 1½-inch scale.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1921-22.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class. (Sq. miles.)	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales. (Sq. miles.)	COSTS OF SURVEY INCLUDING MAPPING. Total costs. (Rs.)	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates. (Rs. per sq. mile.)	REMARKS
						NORTHERN CIRCLE.
No. 1 Party.		*Nil*	*Nil*	71,604 (a)	7·7	(a) Cost of survey of a small area for which credit was taken in last year's report of 8,400 square miles together with cost of mapping of 9,277 square miles undertaken this year. *N. B.*—Last year an area of 8,400 square miles was surveyed but not mapped. Only arrears of the previous years were mapped. The total cost of surveying and mapping 8,400 square miles is Rs. 2,10,840 giving a cost-rate of Rs. 25·1 per square mile.
No. 2 Party—*Central India, Rājputāna and United Provinces.*						
Cultivated plains, open	... **Half-inch** Original Survey ...	492	5,611	1,40,822 (b)	25·1	(b) Excludes Rs. 49,747 cost of training probationers and pupils, Rs. 4,191 debitable to the Allahābād Improvement Trust, Rs. 1,193 debitable to the Executive Engineer, Western Jumna Canal, Rs. 666 debitable to the City Board, Mussoorie, and Rs. 3,351 debitable to the Chief Engineer, Public Works Department, Delhi. (c) Includes 37 square miles surveyed in 1920-21 on half-inch scale and resurveyed in 1921-22 on one-inch scale.
Ditto	... **One-inch** Resurvey ...	2,425				
Ditto	... **One-inch** Revision Survey ...	2,694 (c)				
No. 3 Party—*United Provinces and Nepāl.*						
High, wooded hills ...	... **Two-inch** Original Survey ...	1,969	1,969	1,54,402	78·4	
No. 4 Party—*United Provinces.*						
Cultivated plains, congested with villages in parts.	**One-inch** Revision Survey ...	3,691	3,985	86,923 (d)	21·8	(d) Excludes Rs. 680 debitable to Benares State and U. P. Govt. and Rs. 13,994 cost of training of pupils and probationers.
Cultivated plains and densely wooded low hills.	**One-inch** Original Survey ...	294				
TOTALS, NORTHERN CIRCLE:—		11,565 sq. m		Rs. 4,53,751	Cost-rate 39·2	

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1921-22.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Total of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
						SOUTHERN CIRCLE.
No. 5 Party—*Gwalior, Central India and Central Provinces.*						
Jungle-clad hills, well wooded cultivated plains and part of the Mālwā plateau.	Half-inch Original Survey ...	1,646	4,679	1,38,999	29·7	*(e)* Includes 277·760 square miles of Indore State Forest.
	One-inch Original Survey ...	(e)2,404				
	One-inch Supplementary Survey	615				
	Four-inch Original Forest Survey	14				
No. 6 Party—*Hyderābād.*						
Undulating and cultivated country: wooded hills.	Half-inch Original Survey ...	6,270	6,635	1,16,781	17·6	
	Half-inch Supplementary Survey	365				
No. 7 Party—*Madras and Hyderābād.*						
Open or undulating mostly cultivated	One-inch Original Survey ...	3,810	6,092	1,51,016	24·7	
Low scrub covered hills ...	Two-inch Original Survey ...	333				
Forest-clad hills	One-inch Supplementary Survey	1,949				
No. 8 Party—*Madras and Bombay.*						
Irrigated and cultivated plains and high forest-clad hills in Madras Presidency.	One-inch Original Survey ...	970	4,555	1,41,174 (f)	30·9	*(f)* Includes cost of fair-mapping and fixing scattered auxiliary heights.
	One-inch Supplementary Survey	199				
High hills rising to a height of 4,000 feet and open and cultivated area in Bombay Presidency.	One-inch Revision Survey	3,386				
TOTALS, SOUTHERN CIRCLE:— 21,961* sq. m. Rs. 5,47,970					Cost-rate	25·0

* An area of 365 square miles previously surveyed on the 1½-inch scale has been included.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1921-22.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS OF PLANE-TABLING. Areas on each Scale of each Class.	OUT-TURNS OF PLANE-TABLING. Totals of areas on all Scales.	COSTS OF SURVEY INCLUDING MAPPING. Total costs.	COSTS OF SURVEY INCLUDING MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	
						EASTERN CIRCLE.
No. 9 Party—*Bengal and Bihār and Orissa.*						
Flat and cultivated plains, congested with villages.	One-inch Original Survey ...	462				
Open undulating plains, well populated, varied with rocky scrub covered hills.	One-inch Supplementary Survey	3,267	3,771	1,91,180	50·7	
Rough hills covered with Sāl forest.	Two-inch Original Survey ...	42				
No. 10 Party—*Upper Burma.*						
Densely wooded hills and plains ...	Half-inch Original Survey ...	3,168	3,168	1,74,518	55·1	
No. 11 Party—*Lower Burma.*						
Hills densely wooded, rocky wooded islands and sea coast and mangrove swamp.	One-inch Original Survey ...	1,980	2,150	1,99,029 (*g*)	92·6	(*g*) Includes cost of two-inch forest survey not chargeable to Forest Department.
Flat and hilly forest tracts ...	Two-inch Original Survey ...	170				
No. 12 Party—*Assam.*						
Mainly hills, partly open and partly jungle-clad and plains densely covered with jungle.	Half-inch Original Survey ...	883	2,199	1,80,187 (*h*)	81·9	(*h*) Excludes Rs. 108 cost of mapping four-inch forest boundary plots.
Plains and hills mainly jungle-clad.	One-inch Original Survey ...	1,182				
Plains densely covered with jungle	Two-inch Original Survey ...	134				
No. 21 (Burma Forest) Party—*Upper and Lower Burma.*						
Densely wooded hills and flat ground.	Two-inch Original Survey ...	147	153	1,52,851	999·0	
Wooded hills	Four-inch Original Survey ...	6				
Ditto	Two-inch Original Survey ...	25	39 (*i*)			(*i*) Done by Survey Training School for the party.
Ditto and town of Kalaw	Four-inch Original Survey ...	14				
TOTALS, EASTERN CIRCLE:—		11,480 sq. m.		Rs. 8,97,715	Cost-rate 78·2	
GRAND TOTALS:—		45,006 sq. m.		Rs. 18,99,436	Cost-rate 42·2	

NORTHERN CIRCLE (*vide* Index map No. 1).

14. No. 1 Party.—This party was employed on the completion of the fair-mapping left over from the previous season, comprising 33 sheets on the one-inch and 7 sheets on the half-inch scale. No detail surveys were undertaken during the year.

An area of 2,700 square miles was triangulated, in preparation for a topographical survey on the one-inch and half-inch scales. This area comprises chiefly the tribal tract, in the southern half of the Dera Ghāzi Khān district in the Punjab, but extends westward into the adjoining portion of the Marri-Bugti country in Baluchistān. It is practically tree-less, and rises from about 300 feet to about 4,500 feet above mean sea level. Water is scarce and mostly brackish and communications are few and bad.

15. No. 2 Party.—This party surveyed an area of 4,776 square miles in the Agra, Alīgarh, Muttra, Etah, Mainpurī, Farrukhābād, Etāwah, Cawnpore, Jālaun and Hamīrpur districts of the United Provinces, 137 square miles in Dholpur State in Rājputāna, 143 square miles in Gwalior State and 63 square miles in Baonī State in the Bundelkhand Agency in Central India on the one-inch scale, and 492 square miles in Gwalior State in Central India on the half-inch scale.

The country surveyed consists of cultivated plains, for the most part open and easy, except in a few places where trees were numerous. There was a great deal of broken ground along the banks of the Jumna and Chambal rivers. The area was devoid of hills.

Triangulation was carried out in Gwalior and Datiā States in Central India and in Bharatpur, Dholpur, Karauli and Jaipur States in Rājputāna and an area of 6,560 square miles completed in advance for detail survey on the half-inch scale.

The *traverse* of Allahābād city and Municipal areas for large scale detail survey and of demarcated areas of leased land in Imperial Delhi was completed, (*vide* page 46).

16. No. 3 Party.—This party surveyed an area of 1,969 square miles on the two-inch scale in the Garhwāl and Almorā districts of the United Provinces and in Nepāl. No triangulation was carried out. The survey of the Kumaun hills is being executed chiefly in the interests of the Forest Department (*vide* page 18). The maps are being published on the two-inch scale.

17. No. 4 Party.—This party, which had been in abeyance since 1917, surveyed an area on the one-inch scale of 3,542 square miles in the Azamgarh, Ballia, Bastī and Gorakhpur districts of the United Provinces, 149 square miles in the Champāran and Sāran districts of Bihār and Orissa and 294 square miles in Nepāl, or a total of 3,985 square miles. In addition, 58 square miles of triangulation and 133 linear miles of traversing were carried out in the Champāran district and in Nepāl to supply data for the detail survey during the current season.

The country surveyed consists mainly of well cultivated plains dotted over with lakes, marshes and numerous groves of mango trees and intersected by several rivers the principal of which are the Gogrā, Gandak and Rāptī. Towards the north-east, the country begins to undulate and the alluvial plain gives place to a broken, hilly region which forms the lower slopes of the Someswar range.

A report on the deputation in connection with the disputed boundary between Benares State and the United Provinces will be found on page 46.

18. Training.—No pupil surveyors were entertained during the year. Of those entertained in 1920 and 1921, 13 were promoted unclassified surveyors, 8 were discharged and the remainder have been distributed to the parties for further training during the coming field season.

No soldier surveyors joined for training during the year. Of the batch reported as undergoing training last year, 10 have been reverted to their regiments and, of the remainder, 4 are undergoing their 1st period and 4 their 2nd period of training, 1 having been transferred to the Unattached List.

19. Recess Work.—The fair-mapping of all the sheets of No. 2 and 4 Parties was completed before these parties left for the field. The arrears of No. 1 Party were completed except for 1 one-inch sheet which still had to be examined and 7 half-inch sheets. These latter were taken over by No. 3 Drawing Office and 6 of these will be submitted before the end of the current year.

No. 3 Party's fair-mapping is still in arrears. The forest work of this party entails much extra work. A drawing section is remaining in Mussoorie during the ensuing field season and all arrears will be completed before the commencement of the next recess.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1922:—

Sheets on the one-inch scale	...	...	26
Sheets on the two-inch scale	...	...	24
Sheets on the half-inch scale	...	...	9
Town-guide map	...	...	1

Of these, 28 will be submitted for publication before the end of November 1922.

20. Record Section.—Triangulation data for 12 degree sheets were completed. This section was amalgamated with No. 3 Drawing Office from 1st August 1922.

21. Particulars of special work done by Nos. 2, 4, 20, 22 and 23 (Punjab Rectangulation) (old Sind-Sāgar) Parties and Bhopāl Traverse Detachment will be found on pages 21 and 46 to 48.

SOUTHERN CIRCLE (*vide* Index map No. 1).

22. No. 5 Party.—This party surveyed an area of 4,679 square miles as follows:—2,090 square miles in the Betūl, Hoshangābād and Nimār districts of the Central Provinces, 715 square miles in Indore State and 214 square miles in Dhār State, both of the Central India Agency, on the one-inch scale; 1,299 square miles in Indore State, 97 square miles in Dewās State, 48 square miles in Dhār State, 6 square miles in Rājgarh State, 22 square miles in Jāmnia State and 54 square miles in the Mānpur pargana (British), all of the Central India Agency, 120 square miles in the Amjhera and Ujjain districts of Gwalior, on the half-inch scale; and 14 square miles of reserved forests in the Hoshangābād district of the Central Provinces on the four-inch scale.

The country surveyed consists of jungle-clad hills, well wooded cultivated plains, and part of the Mālwā plateau.

It also triangulated an area of 4,410 square miles in the Central India Agency, Gwalior and the Central Provinces.

23. No. 6 Party.—This party completed an area of 6,270 square miles of half-inch original survey and 365 square miles of half-inch supplementary survey in the Gulbarga, Raichūr and Mahbūbnagar districts of Hyderābād.

690 square miles of supplementary triangulation was carried out in the Amrābād and adjoining reserved forest areas in the Mahbūbnagar and Nalgonda districts of Hyderābād.

The country surveyed is undulating and mostly cultivated except in the wooded hills of the forest areas.

24. No. 7 Party.—This party surveyed an area of 5,950 square miles on the one-inch and two-inch scales in the Kurnool, Anantapur and Cuddapah districts of Madras, and 142 square miles on the one-inch scale in the Raichūr district of Hyderābād, and triangulated an area of 4,462 square miles in the Cuddapah, Chittoor and Anantapur districts of Madras.

The country surveyed is generally cultivated open expanses of level or undulating land, rocky scrub covered hills and the forest-clad ranges of the Nallamalais and Erramalas.

25. No. 8 Party.—This party surveyed 4,555 square miles on the one-inch scale. Of this area, 1,169 square miles fell in the Madura district of Madras and consisted of about equal proportions of irrigated and cultivated plains and of the high forest-clad Palni and Sirumalai hills; of the remaining 3,386 square miles, 2,626 square miles fell in the Poona, Kolāba and Sātāra districts, 663 square miles in Bhor State and 97 square miles in Phaltan State in Bombay; this area included portions of the Western Ghāts rising to a height of 4,000 feet and the more open and cultivated area to the east of the Ghāts. Poona and Kirkee were included in the area surveyed.

26. Training Section.—The section comprised five of the 1920-21 class of Upper Subordinate probationers who had been kept back for further training in plane-tabling and nine Upper Subordinate probationers recruited this year who joined in October as well as 20 pupil surveyors recruited during the year.

The preliminary training of the pupil surveyors in drawing and in plane-tabling on two and four-inch scales in the neighbourhood of Bangalore was continued up to November when the section took the field.

During the field season the 2nd year Upper Subordinates completed their training in plane-tabling and were all posted to various circles in May 1922. Of the 9 new Upper Subordinate probationers four resigned during the field season and five completed their course in plane-tabling and triangulation. Of the 20 pupil surveyors 6 resigned or were discharged as unsuitable and 14 completed their plane-tabling course.

On return to recess, 2 more pupil surveyors were allowed to resign, the remaining 12 continued their training in fair-drawing and were posted to parties in the circle in October 1922. The 5 Upper Subordinate probationers completed their training in traversing, levelling, computations and drawing and after passing a final examination in October 1922 were posted to various circles.

27. Recess Work.—21 one-inch sheets out of 50 surveyed during the year under report were received in the circle office up to the 30th September 1922. All the remaining sheets, except one which will be partly resurveyed, will be fair-mapped before the close of the recess season.

Six original half-inch sheets out of 8 surveyed during the year were received in the circle office up to the 30th September 1922. The remaining 2 sheets will be fair-mapped before the close of the recess season.

Besides the above 4 special forest maps will be completed by No. 5 Party before the close of the recess season.

There are no arrears of drawing from previous season's work.

28. Record Section.—Six triangulation pamphlets and charts were prepared and submitted during the year. Data for 8 degree sheets were compiled in pamphlet form and preserved in the section. All triangulation and traverse records were re-indexed. Data were extracted and supplied on cash payment to a private individual.

EASTERN CIRCLE (*vide* Index map No. 1).

29. No. 9 Party.—This party surveyed an area of 3,771 square miles on the two-inch and one-inch scales in Bengal and Bihār. In Bengal the work fell in the Howrah, Midnapore, and Twenty-four Parganas districts of Bengal and in the Bhāgalpur, Monghyr and Santāl Parganas districts of Bihār.

The area surveyed in Bengal lies on both sides of the Hooghly river, and is flat, and densely populated and that surveyed in Bihār is well populated, undulating and generally open, with small areas of rocky wooded hills.

An area of 540 square miles in the neighbourhood of Patna was traversed for detail survey next season, the work falling in districts Muzaffarpur, Patna, Sāran and Shāhābād of Bihār.

An area of 1,600 square miles was triangulated in the Orissa Tributary States.

30. No. 10 Party.—This party surveyed an area of 3,168 square miles on the half-inch scale in the unadministered area lying between the Putao and Myitkyinā districts of Burma and the Lakhimpur district of Assam. Triangulation was attempted to the south-west of the area surveyed but could not be proceeded with owing to the hostility of the Nāgās. The whole area is covered with dense jungle and, except in the Hukawng, consists of steep and intricate hills rising to 8,000 feet. The Hukawng is a broad level plain crossed by numerous streams, its altitude being about 650 feet.

31. No. 11 Party.—Survey operations were continued in Lower Burma. In the Mergui district, on the mainland and in Sullivan or Lampi island and numerous small islands along the coast, 1,980 square miles were surveyed on the one-inch scale. In the Amherst district, 170 square miles of reserved forest were surveyed on the two-inch scale.

The country surveyed on the mainland consists of a densely forest-clad ridge, rising, in places, to 2,000 feet in elevation, connected in the northern portion of the area with the barrier range along the Siamese frontier and terminating at its southern extremity in the high promontory of Victoria Point. Mangrove swamps and mud flats form the coast. The numerous islands of the Archipelago are thickly wooded, with steep rocky shores, broken by occasional sandy beaches and vary in size from mere rocks to peaks of 2,000 feet.

32. No. 12 Party.—This party surveyed an area of 2,199 square miles on the two-inch, one-inch and half-inch scales in Assam, in the districts of Cāchār, Nowgong, Sibsāgar and the Nāgā Hills and in Manipur State.

An area of 3,376 square miles of triangulation and 277 linear miles of traversing (covering an area of 1,017 square miles) were carried out in the district of the Nāgā Hills, Manipur State and the Sadiyā Frontier Tract, in advance of detail survey.

The area surveyed was hilly, ranging from 400 feet to 6,000 feet, approximately; almost the whole of it was covered with dense forest.

33. No. 21 (Burma Forest) Party.—The work done by this party is included in that shown under Forest Surveys, Eastern Circle, pages 19 and 20.

The area over which operations extended is hilly, rising to 5,000 feet and covered with very dense forest growth.

34. Training.—This was carried out in No. 9 Party and in the Maymyo Survey School.

In No. 9 Party results were encouraging, an average out-turn of 68 square miles of survey being obtained from each pupil. In all, 2 military officers, 1 Upper Subordinate officer, 1 soldier surveyor and 12 pupil surveyors were under training of whom 3 pupil surveyors have been discharged as unlikely to become good surveyors.

At Maymyo results were less satisfactory. Since the school was formed in December 1920, 70 pupils, mostly Burmans, have been under training for different periods. 31 of these have been discharged as unlikely to become surveyors, 4 absconded or resigned and 6 were discharged or resigned after having been trained and drafted to parties and only 15 are sufficiently trained for ordinary field work. The experiment of recruiting Burmans to train as surveyors has not been successful and it is proposed to close the school from November 1st when the few partially trained pupils still at the school will be attached to parties to complete their training.

35. Recess Work.—The sheets which had to be drawn by the parties of the Eastern Circle during the recess season numbered 56 including 7 special forest sheets and 1 sheet in arrears from the previous year's drawing. By the 30th September, 6 of these sheets had been received in the circle office and all the remaining sheets will be received and sent for publication before the beginning of next recess season.

II.—FOREST SURVEYS.

36. Details of the topographical survey of reserved forests executed by field parties of the Survey of India during the year under report, are given below. In the majority of cases, the surveys were carried out on the scale of 2 inches to a mile, but occasionally the 4 inches and 1 inch to a mile scales were adopted. Boundary surveys were made where required, and plots prepared on the 4-inch scale.

NORTHERN CIRCLE.

37. United Provinces. Kumaun Forest Circle.—In the *North Garhwāl, Central Almorā, and East Almorā Forest Divisions,* reserved forest areas of 158, 22 and 361 square miles respectively, were surveyed on the 2-inch scale, thus completing the survey of reserved forests in the two latter forest divisions.

SOUTHERN CIRCLE.

38. Central Provinces. Northern Circle.—In the *Hoshangābād Forest Division,* the following reserved forest areas, totalling 13·764 square miles, were surveyed on the 4-inch scale :—

Name of Block or Extension.			Area in square miles.
Joga Kalan	A	... ...	1·759
Bichola Extension	B	... ...	0·259
„ „	C	... ...	0·168
Indpura „	D	... ...	10·204
Lokartalai „	E	... ...	0·033
„ „	F	... ...	0·149
„ „	G	... ...	0·619
„ „	H	... ...	0·251
Budhimai „	K	... ...	0·189
Dimdadeh „	L	... ...	0·133
		Total ...	13·764

39. Madras. II Forest Circle.—In the *South* and *West Kurnool Forest Division,* an area of 5·96 square miles was surveyed on the 1-inch scale in the Dudrala Reserved Forest and of 241·63 square miles on the 2-inch scale in the under-mentioned reserved forests :—

Name.		Area in square miles.
Gādidenadugu	... ...	7·53
Loddipalle	... ...	2·00
Yaparlapādu	... ...	13·38
Voddaman	... ...	1·89
Rāmallakota	... ...	2·85
Yemboyi	... ...	4·69
Lanjabanda	... ...	6·00
„ Extension	... ...	5·35
N. Dhone (part)	... ...	7·08
Rāngāpuram A and B	... ...	8·85
	Carried over ...	59.62

Name.		Area in square miles.
	Brought forward ...	59·62
Betamcherla	... ...	14·08
Pānem	... ...	36·05
Gani	... ...	65·43
Owk and Extension (part)	... ...	41·15
Giddalore Block 1	... ...	4·95
„ „ 2	... ...	10·12
Yedanada	... ...	1·87
Mittapalli	... ...	4·38
Alamur	... ...	0·28
Rāmavaram	... ...	3·70
	Total ...	241·63

III Forest Circle.—In the *North* and *South Cuddapah Forest Division*, a total area of 44·77 square miles was surveyed on the 2-inch scale, of the under-mentioned reserved forests :—

Name.					Area in square miles.
Dhodiyam	A	...	...	...	6·15
„	B	...	...	...	3·43
Gandikota	N	...	...	...	1·97
„	S	...	...	...	8·39
Bhanikotamale		...	...	...	16·50
Dottudapalle (part)		...	...	...	3·58
Malnidi Kantaldimmi		...	...	...	3·79
Penner		...	...	...	0·96
			Total	...	44·77

EASTERN CIRCLE.

40. Bihār & Orissa. Bihār & Orissā Forest Circle.—In the *Santāl Parganas Forest Division*, an area of 1 square mile comprising the Kelhari closed Block was surveyed on the 1-inch scale, and areas of 2 and 40 square miles of the Balghora closed Block and the old Reserve respectively were surveyed on the 2-inch scale.

41. Assam. Western Forest Circle.—In the *Cāchār Forest Division*, an area of 96·57 square miles of the Langting Mupā Forest Reserve was surveyed on the 1-inch scale, the scale of 2 inches to the mile, on which a portion of this reserve was surveyed last year, having been reduced to 1-inch with the concurrence of the Conservator of Forests.

Eastern Forest Circle.—In the *Nowgong Forest Division*, areas of 10·25 and 15 square miles of the Lumding and Kaki Reserved Forests respectively were surveyed on the 1-inch scale, and the whole of the Dhansiri Reserve amounting to 74·14 square miles was surveyed on the 2-inch scale.

In the *Sibsāgar Forest Division*, the whole of the Rangāpahār Reserved Forest amounting to 34 square miles was surveyed on the 2-inch scale.

42. Burma. Northern Forest Circle.—In the *Mansi Forest Division*, the survey of an area of 3·8 square miles on the 4-inch scale completed the survey of the Mode Reserved Forest.

Central Forest Circle.—In the *Meiktila* and *Southern Shan States Forest Divisions*, areas of 26 square miles on the 2-inch and 18 square miles on the 4-inch scale were surveyed in the Kubyin and Kalaw Reserved Forests respectively. In the former reserve, 37 linear miles of its boundaries were traversed.

Tenasserim Forest Circle.—In the *West Salween Forest Division*, (New *Thaton Division*), 250 linear miles of the boundaries of the following reserves were traversed: Kalemataung, Martaban, Danu (fuel), Kyosein, Wetwundaung, Bilin, and Pabein.

In the *Ataran Forest Division*, areas of 64·85, 104·8, and 0·8 square miles of the Kyonkawun, Kyaikkamaw and Tagundaing Reserved Forests respectively were surveyed on the 2-inch scale.

Delta Forest Circle.—In the *Bassein Forest Division*, 47 square miles of triangulation and 299 linear miles of traversing were carried out in the Chaungtha, Mezali, Sinma, Myittaya and Thitpok Reserves, and 146·9 square miles of surveys on the 2-inch scale as follows:—

Shwemyindin Reserve	...	...	...	9·3	square miles.
Podaw	„	...	...	...	29·6	„
Kyeintali	„	...	...	...	34·3	„
Sitsayan	„	...	...	...	29·5	„
Chaungtha	„	...	...	...	26·5	„
Unclassed Forest		...	...	...	17·7	„
			Total		146·9	„

III.—CANTONMENT AND LARGE SCALE SURVEYS.

43. No. 20 Party.—During the year the party completed the survey of Bangalore, Deolāli and Ahmadābād cantonments on the sixteen-inch scale, and in addition, a considerable area around Deolāli on the six-inch scale, to illustrate proposed military extensions. The remaining portions of the bāzār areas in Bangalore were completed on the scale of one inch to fifty feet, as well as the bāzārs in Deolāli and Ahmadābād on the sixty-four-inch scale.

31·94 linear miles of traversing and 96·83 linear miles of levelling were completed in conjunction with these surveys at a cost of Rs. 237·66 and Rs. 18·90 per mile respectively.

The fair-mapping of the following cantonments has been completed during the year:—Pallāvaram, St. Thomas's Mount, Poonamallee, Velichi and West Hill. 39 sheets have been submitted to press; of the remainder, comprising 96 sheets, 46 are nearly ready and the rest well in hand.

The out-turns and cost-rates of the several classes of survey are as follows:—

1. Sixteen-inch, original, 2,064 acres @ Rs. 4·55 per acre.
2. Sixteen-inch, revision, 3,461 acres @ Rs. 1·04 per acre.
3. Six-inch, original, 40·21 square miles @ Rs. 190·22 per square mile.
4. One inch to fifty feet, original, 65·63 acres @ Rs. 9·82 per acre.
5. Sixty-four-inch, original, 48·36 acres @ Rs. 16·29 per acre.
6. Sixty-four-inch, revision, 58·00 acres @ Rs. 13·91 per acre.

The average daily out-turns being:—

8·22, 10·15, 57·60, 0·66, 2·20, 1·41 acres, respectively.

The total areas fair-drawn, with cost-rates, are as follows:—

1. 4,636·00 acres on the sixteen-inch scale @ Rs. 3·95 per acre.
2. 20·10 square miles on the six-inch scale @ Rs. 134·57 per square mile.
3. 75·00 acres on the one inch to fifty feet scale @ Rs. 196·76 per acre.
4. 666·00 acres on the sixty-four-inch scale @ Rs. 7·39 per acre.

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scales of 16 and 64 inches = 1 mile, up to the end of 1921-22.

(1) Agra Cantonment.
(2) Aurangābād do.
(3) Bakloh do.
(4) Balūn or Thath (Dalhousie) Camp area.
(5) Bannu Cantonment.
(6) Chaman do.
(7) Chitrāl Station.
(8) Dehra Dūn Cantonment.
(9) Deoli do.
(10) Drazinda Out Post.
(11) Drosh Cantonment.
(12) Delhi New do.
(13) Erinpura do.
(14) Fort Lockhart.
(15) Ghairat Station.
(16) Guna Cantonment.
(17) Hangu do.
(18) Hāpur (Bābūgarh) Remount Depôt.
(19) Hosūr do.
(20) Jandola Out Post.
(21) Jatta do.
(22) Jhelum Cantonment.
(23) Jullundur do.
(24) Kālka Cantonment.
(25) Kamptee do. and Bāzār.
(26) Karāchi Port Trust (Manora)
(27) Landour Cantonment.
(28) Meerut do. and Bāzār.
(29) Nasīrābād do. do.
(30) Nīmach do. do.
(31) Peshāwar do. do.
(32) Quetta do.
(33) Quetta Fort.
(34) Quetta Civil Station.
(35) Rājkot Cantonment.
(36) Rāwalpindi do.
(37) Sahāranpur Remount Depôt.
(38) Sanāwar Cantonment.
(39) Saugor do.
(40) Siālkot do.
(41) Simla Indian Infantry Lines.
(42) Sītābaldī Fort (Nāgpur).
(43) Thal Cantonment.
(44) Topa do.
(45) Zām Out Post.

IV.—THE TRIGONOMETRICAL SURVEY.

GEODETIC OPERATIONS.

44. No. 13 Party.—Astronomical.—During the year advantage was taken of the fact of Bt.-Major K. Mason, M.C., R.E., being in Kashmīr on other survey work, to get this officer to carry out Talcott observations for latitude at four stations of the Kashmīr triangulation, namely:—

Gogipatri, Poshkar, Zebanwan and Reban. The observations at the two former were of the nature of revision, the earlier observations at those two stations, in 1860, having given indications of defects in the instrument used, with the result that the values of latitude then obtained have always been looked upon with some suspicion. The computation of this work is in hand but the results are not yet available.

The personnel of the party were employed at Headquarters offices of the Trigonometrical Survey.

45. No. 14 Party.—Pendulum, No. 15 Party.—Triangulation, and No. 19 Party.—Base Line Operations.—No field operations were carried out by these three parties, the personnel being employed at the Headquarters offices of the Trigonometrical Survey.

46. No. 16 Party.—Tidal Operations.—Tidal registrations were carried out during the year by means of self registering tide-gauges at the following stations:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		Remarks.
1. Aden	1879 ...	Still working	43		
2. Karāchi	1868 ...	1880	13	54	*With a small tide-gauge.
	1881 ...	Still working	41		
3. Bombay (Apollo Bandar)	1878 ...	,,	44		
4. Bombay (Prince's Dock)	1888 ...	,,	34		
5. Madras	1880 ...	1890	10	37	
	Restarted 1895	Still working	27		
6. Kidderpore ...	1881 ...	,,	41		
7. Rangoon ...	1880 ...	,,	42		
8. Moulmein ...	1880 ...	1886	6	19	
	Restarted 1909	Still working	13		
9. Port Blair ...	1880 ...	,,	42		

In addition, the actual times and heights of high and low-water at Bhaunagar, Chittagong and Akyab were observed by watch and tide-pole, under the supervision of the Port Officers, a monthly record of the observations being forwarded to this office.

Hourly readings of the height of the water, determined by a tide-pole, were taken at Basrah throughout the day and night, and were supplied to this office weekly by the Director, Inland Water Transport, Mesopotamia. The observations for the year, commencing 1st January 1921, were reduced by the method of harmonic analysis and the constants thus deduced were used in the computation of data for the Basrah tide-tables for 1923.

Tide predictions for the 1923 tide-tables for the Indian ports, including Basrah, were carried out by means of the tide-predicting machine set up at the office of the Superintendent of the Trigonometrical Survey, Dehra Dūn, where, subsequently, the tables were published. Their despatch to Port authorities will be completed by about the end of October 1922.

Tidal registrations have been carried out satisfactorily at nine observatories, except in the case of Bombay (Prince's Dock). Registrations will be discontinued at Prince's Dock, Bombay, which observatory will, however, be kept open by the Port authorities for their own purposes.

During the past year these observatories were all inspected.

47. The following table shows the annual and decadal percentages of error in the predicted times and heights of high and low-water at the nine stations, where observations have been taken by self-registering tide-gauges :—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

Year.	AT OPEN COAST STATIONS.						AT RIVERAIN STATIONS.					
	Number of Stations.	IN TIME.		IN HEIGHT.			Number of Stations.	IN TIME.		IN HEIGHT.		
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.
		H.W.—L.W.		H.W.—L.W.		H.W.—L.W.		H.W.—L.W.		H.W.—L.W.		H.W.—L.W.
1912	6	82	82	97	98	97	98	4	70	58	74	62	94	91
1913	6	83	82	97	97	98	99	4	68	55	70	58	94	88
1914	6	77	79	96	97	98	98	3	75	67	71	55	92	84
1915	6	82	82	98	98	96	96	3	76	66	73	67	94	92
1916	6	81	82	96	97	96	99	3	81	68	73	62	93	87
1917	6	75	72	96	98	96	97	3	78	65	69	64	92	88
1918	6	83	82	97	97	97	96	3	76	63	66	65	90	89
1919	6	78	75	96	97	97	98	3	74	65	70	69	93	92
1920	6	82	81	94	97	97	98	3	76	66	64	62	89	86
1921	6	77	72	94	97	97	99	3	74	66	75	71	92	94
Average of ten years.	...	80	79	96	97	97	98	...	75	64	71	64	92	89

48. *Tide-predicting machine.*—This machine was received from the National Physical Laboratory, Teddington, England, towards the end of September 1921. After necessary repairs had been carried out, it was erected at Dehra Dūn, the predictions for the 1923 tide-tables being completed by the middle of August 1922.

49. No. 17 Party.—Levelling.—Four double and three special detachments were employed during the past season on the levelling operations summarised below :—

(*a*) *In Bengal and Bihār*, for the Nadiā Rivers Scheme.

(*i*) From Dhuliān to Jangipur.

(*ii*) From Tinpahār to Barharwā.

(*b*) *In Bengal*, for the Irrigation Department.

(*i*) From Calcutta, *via* Bārāsat, Husainābād, Jessore and Jhenida to Chuādānga.

(*ii*) From Jessore to Bārāsat.

(*c*) *In Bihār.*

(*i*) From Jhārsugrā to Purūlia.

In the Central Provinces and United Provinces.

(*ii*) From Jhānsi to Saugor.

(*iii*) From Garhmuktesar to Alīgarh.

These lines were levelled to provide a cross connection between the old level lines.

(*d*) *In Bombay*, for the Sukkur Barrage Project.

(*i*) From Shikārpur (Sind) to Kambar.

(*ii*) From Wāriāso to Rato-Dero.
(*iii*) From Madad Chāndia to Mehar.
(*iv*) From Ruk to Sehwān.
(*v*) From Daur to Lundo.
(*vi*) From Shāhpur to Mahrābpur.
(*vii*) From Tando Alāhyār to Hyderābād (Sind).
(*viii*) From Rohri to Jām Sāhib.

(*e*) *In Bombay*, for the Nīra Right Bank Canal Scheme.
(*i*) From Nīra Bridge to Bhatgar.
(*ii*) From Nīra Bridge to Zalki.

(*f*) *In Bombay, Punjab and Rājputāna.*
(*i*) From Viramgām to Rājkot.
(*ii*) From Rājkot to Jorya.
(*iii*) From Jorya to Shikārpur (Cutch).
(*iv*) From Shikārpur (Cutch) to Navānār.
(*v*) From Navānār to Nakhtarāna.
(*vi*) From Jacobābād to Shikārpur (Sind).
(*vii*) From Shikārpur (Sind) to Rohri.
(*viii*) From Rohri to Reti.
(*ix*) From Reti to Khānpur.
(*x*) From Khānpur to Bahāwalpur.
(*xi*) From Bāhāwalpur to Multān.
(*xii*) From Multān to Jhang.
(*xiii*) From Khānpur to Islāmgarh.
(*xiv*) From Islāmgarh *via* Sheo, Barmer, Bālotra and Luni Junction to Mārwār Pālī.
(*xv*) From Surat to Dhūlia.

These lines were levelled in accordance with the procedure prescribed for high precision work, and form lines 102, 104, 105 and 113 of the new level net of India.

(*g*) *In Bombay.*
(*i*) From Nāndgaon to Ahmadnagar, *via* Manmād.
(*ii*) From Sholāpur to Bijāpur, *via* Zalki.

These lines were levelled to form cross connections between lines of the old net.

(*h*) *In Punjab and Kashmīr.*
(*i*) From Wazīrābād to Sūchitgarh.
(*ii*) From Sūchitgarh to Islāmābād.

These lines were levelled to complete the circuit taken into Kashmīr in season 1912-13.

The total out-turn consisted of 1,452 miles of primary levelling and 2,195 miles of secondary levelling; of this 1,383 miles of secondary levelling were executed at the request of Local Governments, Irrigation Departments, &c.

MAGNETIC SURVEY.

50. No. 18 Party.—Magnetic.—The declination, horizontal force and vertical force magnetographs continued in operation throughout the year at the Dehra Dūn and Toungoo observatories, and daily absolute magnetic observations were taken regularly by the observers in charge. The observatories were visited during the field season and observations, consisting of declination, dip and horizontal force, were taken for the comparison of instruments.

The Kodaikānal and Alibāg observatories, under the control of the Meteorological Department, were also visited by the officer in charge of the magnetic party.

Observations at Repeat Stations.—Magnetic observations were taken this field season at the six repeat stations—Quetta, Karāchi, Bina, Dibrugarh, Barrackpore and Waltair; these stations are visited annually to supplement the 5-yearly observations at all repeat stations, taken in order to obtain reliable determinations of the annual changes in the magnetic elements.

Publication of the results of the magnetic survey.—The final reduction of observations taken at observatories, in the field and at repeat stations, to the epochs 1909·0 and 1920·0 is very nearly completed and it is hoped that the tables of the results and the necessary maps &c., most of which have already been sent to press, will be ready for publication about the middle of 1923.

Special observations.—In response to an appeal by Dr. L. A. Bauer, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, addressed to magnetic observatories in all countries, for co-operation in special simultaneous magnetic observations in connection with the Solar eclipse of the 21st September 1922, magnetic observations were taken at the Dehra Dūn, Toungoo and Kodaikānal observatories. Declination, dip and horizontal force were observed at Dehra Dūn, but at the Toungoo and Kodaikānal observatories, where the observatory staffs are small, only declination observations were taken. The three observatories were favourably situated within the shadow belt of the eclipse and it is hoped that the results of the observations obtained in India will be of value to Dr. Bauer in his investigation of the effects of the eclipse.

The magnetic elements at the observatories.—The computation and tabulation of the values of declination, dip, horizontal force and vertical force for the three observatories, Dehra Dūn, Toungoo and Kodaikānal, for the year 1921, have been completed; the mean values of these elements derived from all days, excluding those of great disturbances, are given in the table below :—

MEAN VALUES OF THE MAGNETIC ELEMENTS AT THE OBSERVATORIES IN 1921.

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 45 4·2	E 1 47·1	·32945	·33025
Toungoo ...	18 55 45 N 96 27 3 E	N 23 7·0	W 0 26·8	·39132	·16704
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 38·5	W 1 54·2	·37832	·03071

V.—GEOGRAPHICAL SURVEYS AND EXPLORATION.

51. Geographical Surveys in Bhutān and Tibet.—Captain H. R. C. Meade, I.A., and Mr. Bansi Ram, Sub-Assistant Superintendent, accompanied the Political Officer of Sikkim on a mission to Bumtang to confer the insignia of the G. C. I. E. on His Highness the Mahārāja of Bhutān.

Leaving Yatung on June 20th, the party reached Bumtang on the 20th of July and returned by the Manlakachung La Pass through the southern portion of Tibet by the Yamdo Tso lake to Gyāntse, where it arrived on the 27th of August.

Areas aggregating 6,500 square miles were plane-tabled on the scale of one inch to 4 miles, the work being based generally on triangulation carried out during the journey.

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

52. Brief reports of the work carried out during the year under review in the six offices administered by the Map Publication Office are given in paras. 54 to 58, 66, 67 and 81.

53. The classes of maps for the publication of which the Head Quarter Offices are responsible are as follows:—

(*a*) Topographical maps on the one-inch scale.
(*b*) Topographical maps on the half-inch scale.
(*c*) Topographical maps on the quarter-inch scale.
(*d*) (*i*) Geographical maps on the 1:1,000,000 scale (about 1 inch = 16 miles).
(*ii*) La Carte Internationale du Monde on the 1:1,000,000 (about 1 inch = 16 miles).
(*e*) Geographical maps on the 1:2,000,000 scale (about 1 inch = 32 miles).
(*f*) General maps on the same and smaller scales.
(*g*) Special maps.

The progress made in the publication of each of these classes is detailed below:—

(a) **Topographical maps on the one-inch scale.**—During the year 95 modern sheets have been published.

Index map No. 2 at the end of this report shows the progress made in the publication of the modern one-inch public sheets, and the following table gives the annual output of these sheets since the modern topographical surveys were begun:—

Years of publication.	Number of one-inch sheets published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
1915-16	85	69	50	204
1916-17	23	40	22	85
1917-18	18	12	13	43
1918-19	32	19	6	57
1919-20	15	37	52	104
1920-21	15	11	19	45
1921-22	**20**	**46**	**29**	**95**
Total published ...	726	548	549	1,823
Probable number of one-inch sheets which will not be published owing to the area covered by them being included in the programme for survey and publication on the half-inch scale	911	564	473	1,948
Approximate number remaining for publication ...	515	917	1,015	2,447
Approximate number of public one-inch sheets in India	2,152	2,029	2,037	6,218

In addition to the above, preliminary editions (in colours) of 17 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision.

47 modern one-inch, 9 preliminary editions of one-inch, and 79 old style one-inch sheets have been reprinted during the year.

(b) **Topographical maps on the half-inch scale.**—Index map No. 3 at the end of this report shows the progress made in the publication of the modern half-inch public sheets. This series now forms the *tactical* map of India, having taken the place of the quarter-inch maps in this respect. It was commenced in 1914; most of the sheets published up to date are reductions from the one-inch map, but others are from direct half-inch surveys.

The following table gives the annual output of these sheets :—

Years of publication.	Number of half-inch sheets published.		
	Drawn from component one-inch sheets.	Surveyed on half-inch scale.	Total.
1914-15	...	1	1
1915-16	21	4	25
1916-17	50	6	56
1917-18	59	6	65
1918-19	26	4	30
1919-20	31	8	39
1920-21	59	2	61
1921-22	**75**	**7**	**82**
Totals	321	38	359
Approximate total number of half-inch sheets in India	.....	....	1,630

14 modern public half-inch sheets have been reprinted during the year.

(c) **Topographical maps on the quarter-inch scale.**—These maps are prepared in "degree" sheets which include 1° of latitude and 1° of longitude, *i.e.*, the area covered by 16 one-inch sheets, or 4 half-inch sheets.

Index map No. 4 at the end of this report shows the progress made in the publication of the modern quarter-inch public sheets.

The following table gives the annual output of these sheets :—

Years of publication.	Number of "Degree" sheets published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	1	3	3	7
1915-16	...	1	4	5
1916-17	1	...	3	4
1917-18	...	...	4	4
1918-19	...	3	8	11
1919-20	4	...	4	8
1920-21	1	...	...	1
1921-22	**1**	**3**	**6**	**10**
Totals	17	15	39	71
Approximate number of "degree" sheets in India	170	140	140	450

1 preliminary sheet in colours from comparatively modern surveys has been published and 14 are in hand.

In addition to the above, 8 modern and 2 preliminary public quarter-inch sheets have been reprinted during the year.

39 quarter-inch sheets have been prepared in No. 1 Drawing Office from the old engraved quarter-inch Atlas sheets brought up to date and published (in black only) as provisional issues; and 12 of such sheets which were published previously have been reprinted during the year. These "provisional" quarter-inch sheets, including those in hand, now cover the greater part of the area of India for which modern "degree" sheets are not likely to be available for some time.

(d) **Geographical Maps on the 1:1,000,000 scale.**—(*i*) **The "India and Adjacent Countries" Series** (*Vide* Index map No. 5).—During the year 3 new sheets of this series have been published, 6 sheets have been engraved and 13 sheets have been reprinted.

(*ii*) **La Carte Internationale du Monde.**—(*Vide* Index map No. 6).—A full description of the genesis of this series was given in the General Report for 1913-14; 2 sheets of this series have been published during the year. 12 sheets have been published up to date.

(e) **Geographical Maps on the 1:2,000,000 scale.**—(*Vide* Index map No. 7).—No new map of this series was published during the year.

(f) **General Maps on the same and smaller scales.**—The engraved plates of all these maps have been corrected and brought up to date as far as possible during the year.

(g) **Special maps.**—The annual edition of the Railway Administration map (on the scale of 1 inch = 64 miles) has not been published during the year; three provincial maps and the map of India and Adjacent Countries (on the scale of 1 inch = 32 miles) have been reprinted.

Numerous special maps have also been prepared and printed for the Army, for Local Governments, Railways and for other Departments.

5 "Town-guide" maps, and 4 "Environ" maps on the scales 12 inches = 1 mile and 4 inches = 1 mile, respectively, have been published.

The "Town-guide" maps published during the year are those of Allahābād, Benares, Ferozepore, Lahore and Peshāwar.

A map of Mount Abu on scale 6 inches = 1 mile has been published and a city map reprinted during the year.

54. Map Record and Issue Office.—A larger number of requisitions and enquiries for maps have been received both from the public and from Government Officials than during the previous year, resulting in larger sales.

The value of map issues was Rs. 3,41,488 which may be compared with Rs. 2,11,014 in 1913-14. This increase is due to improved management, advertising, and increases in the price of the maps.

Demands for our new Catalogue of Maps have been so heavy that all copies printed in 1921 are exhausted, and a revised edition is under preparation.

A Class I Officer has been attached exclusively to this office since 3rd March 1922, and a great deal of sorting and re-arrangement has been effected. One notable economy has been the conversion of large numbers of obsolete maps into envelopes, office forms, &c., for the use of the department, instead of selling them off as waste paper.

A branch office for the convenience of the Calcutta public has been temporarily established at 5, Esplanade East, for the display and sale of departmental publications. The resulting increase in sales has so far been most satisfactory.

A system of enclosed steel shelves for storage of maps is urgently needed and a small beginning in this direction has been made.

An Office Manual of Instructions for the conduct of business in the Map Record and Issue Office was also published during the year.

Issues.—FROM THE MAP RECORD AND ISSUE OFFICE, 1921-22.

YEAR.		ON BOOK TRANSFER (TO GOVERNMENT OFFICIALS).		ON CASH PAYMENT (TO PRIVATE INDIVIDUALS AND MAP AGENTS).		FREE ISSUES.		TOTAL.	
		Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.
1921-22	Departmental Maps.	71,641	77,757	45,560	49,560	60,061	66,169	177,262	1,93,486
	Extra-departmental Publications.	* 1,151,191	* 1,32,753	59,190	12,515	7,751	2,734	1,218,132	1,48,002
	Total ...	1,222,832	2,10,510	104,750	62,075	67,812	68,903	1,395,394	3,41,488
1920-21	Total ...	1,593,868	2,06,402	136,728	59,568	56,824	28,175	1,787,420	2,94,145
1919-20	Total ...	1,271,851	1,66,823	136,971	55,468	77,044	50,859	1,485,866	2,73,150
1913-14	Total ..	.....	94,539	. . ..	58,832	56,491	57,643	.....	2,11,014

NOTE :—The figures for 1913-14 were obtained by combining those for issues made by the Photo.-Litho. Office with those for the Map Record and Issue Office as in that year both offices issued maps.

* These figures include 26,850 diagrams, value Rs. 2152, issued by the Photo.-Litho. Office.

Table IV.—Publications received in Map Record & Issue Office, during the year 1921-22.

A.—From the Calcutta Printing Offices, (including the Engraving Office).

Class of Maps.	Scale.	Number of different maps of each class received.		Number of sheets printed.	Value.
		New Publications.	Reprints and New Editions.		
		DEPARTMENTAL.			
GENERAL MAPS.					*Rs.*
Maps of India	Various	.	1	1,000	500
GEOGRAPHICAL MAPS.					
Map of India and Adjacent Countries	1 =32 miles	...	2	18,000	18,000
Southern Asia Series	1:2,000,000	...	...	...	...
India and Adjacent Countries Series	1:1,000,000	3	13	7,200	10,800
La Carte Internationale du Monde	1:1,000,000	2	.	600	600
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern	1″=4 miles	12	21	22,535	32,489
Do. (Prely.)	1 =4 miles	1	2	1,250	1,875
Do. (Provl.)	1″=4 miles	40	15	13,000	16,450
Half-inch, Modern	1″=2 miles	87	21	53,870	98,805
Do. (Prely.) ..	1″=2 miles	...	...	...	...
One-inch, Modern	1 =1 mile	99	57	74,090	1,08,135
Do. (Prely.)	1″=1 mile	17	9	10,000	15,000
Do. (Provl.)	1″=1 mile	1	.	250	375
Old Style sheets	Various	.	79	16,250	27,204
SPECIAL MAPS.					
District Maps	1″=4 miles	...	..	...	..
Administration Report Maps ...	1″=8 miles	.	3	670	257
Provincial Maps	Various	...	3	1,685	2,133
Plans of Cities and Cantonments ...	Various	10	4	6,970	12,891
Index Maps	Various	...	75	107,625	12,433
Miscellaneous Maps	Various	56	11	31,479	17,933
Total	.....	**328**	**316**	**366,474**	**3,75,880**
		EXTRA-DEPARTMENTAL.			
Maps	Various	233	59	197,186	59,238
Plans and diagrams	Various	1,801	41	246,271	28,087
Illustrations	.....	185	1	57,989	10,593
Miscellaneous ...	.....	233	111	822,712	41,134
Total ...	.....	**2,452**	**212**	**1,324,158**	**1,39,052**
Grand Total	.....	**2,780**	**528**	**1,690,632**	**5,14,932**

B.—From the Trigonometrical Survey Office, Dehra Dūn.

Various	Various	12	18	1,335	9,625

C.—LETTERPRESS.

1. Survey of India General Report, 1920-21. *Price Rs. 2 or 4s.*
2. Catalogue of Maps published by the Survey of India, 1921. *Price Re. 1 or 2s.*
3. Hand-book of Topography, Chapter VI, 1922. *Price Re. 1 or 2s.*
4. Survey of India Copy Book of Lettering, 1921. *Price Rs. 3-8 or 7s.*
5. A Description of the Survey of India Small Scale Maps (Gratis).

55. No. 1 (Head Quarters) Drawing Office.—The organization of the office remained substantially the same as last year.

The work carried out by the various sections was as follows:—

(1) *The Compilation Section.*—

(*a*) "La Carte Internationale du Monde au 1,000,000".—Two sheets sent in for publication during 1920-21, were published during the year under report. Seven sheets were reported in hand last year, two new sheets were taken up during the year. Of the nine sheets, contour patterns of four sheets and outline patterns of two sheets have been supplied to the Engraving Office. Outline patterns of the remaining three sheets are in hand. Stump-shaded original of one of the four completed sheets is in hand.

(*b*) The Southern Asia Series, scale 1:2,000,000.—Of the seven sheets reported in hand last year, complete contour pattern of one sheet, and complete outline and partly complete contour patterns of two sheets have been sent to the Engraving Office. Of the four remaining sheets, contour patterns of three sheets and outline pattern of one sheet are in hand. No new sheet was taken in hand during the year under report.

(*c*) India and Adjacent Countries, scale 1:4,000,000.—Corrections in Tibet area received from the Superintendent of the Trigonometrical Survey have been carried out and sent to the Engraving Office.

(*d*) Miscellaneous.—

(*i*) Shaded originals of two sections of the 32-mile map of India have been revised for reprint.

(*ii*) Various indexes for the Catalogue of Maps have been brought up-to-date.

(*iii*) The usual indexes for the General Report have been completed.

(2) *The "One-Millionth" Section.*—

(*a*) Engraved editions.—Of seven completed sheets of last year, five were sent in for publication, and stump-shaded originals of the remaining two sheets are in hand. There were four sheets in hand at the close of the last year and two new sheets have been taken up during the year under report. Of these six sheets, outline and contour patterns of one sheet have been sent to the Engraving Office and outline patterns of the remaining five sheets are in hand.

(*b*) Helio. editions.—One sheet has continued in hand during the year under report.

(*c*) Reprints.—Seven sheets have been brought up-to-date and sent to press. One is in hand.

(*d*) Miscellaneous.—The border specimen for 1/M sheets (Helio. edition) is being revised, engraved patterns of twelve standard indexes have been prepared and sent to the Engraving Office for correction of plates.

(3) *The Quarter-Inch Section.*—

(*a*) Original compilation and drawing.—Thirteen ¼-inch sheets (preliminary edition) were in hand last year and four new sheets (3 preliminary and 1 modern) have been taken up this year. Of these seventeen, two have been transferred to the Southern Circle for completion, four completed and sent to press, and the remaining eleven are in hand.

(*b*) Reprints.—New contour originals of two sheets in hand last year have been completed and the sheets have been sent to press for reprint. Three ¼-inch and one ½-inch sheets were brought up-to-date and sent to press for reprint. Guide showing corrections for the reprint of one engraved ¼-inch sheet was prepared and sent to the Engraving Office for correcting the plates.

(*c*) Miscellaneous.—

(*i*) Stump-shaded originals of 24 ¼-inch sheets were prepared (including 19 for No. 6 Drawing Office) and sent to press.

(*ii*) Grid indicator scales were drawn on the originals of fourteen sheets.

(*iii*) Originals for standardised foot-notes for transfrontier ¼-inch and ½-inch sheets were drawn.

(*iv*) Black prints of plane-table sections of 30 sheets have been pasted together and sent to press for supply of blue prints to parties for fair-drawing.

(4) *The Reprint Section.*—

(*a*) 43 old style (15′ × 30′) one-inch sheets (including 16 sheets in hand at the close of last year) were corrected and sent to press for reprint; of these, four fragmentary sheets were completed to edges from available material. Seventeen sheets remain in hand.

(*b*) Seven one-inch sheets (including one in hand at the close of last year) were corrected to modern graticules, brought up-to-date and sent to press.

(*c*) 44 (provisional) ¼-inch sheets (including 12 in hand at the close of last year) were compiled from the Indian Atlas and other material and sent to press for publication. Of these, six fragmentary sheets were completed to edges from available material. Eleven sheets are still in hand.

(*d*) Ten ¼-inch sheets compiled from Indian Atlas material (including five in hand at the close of last year) were corrected against office copies and sent to press for reprint. Eleven sheets are still in hand.

(*e*) Three Indian Atlas sheets and four miscellaneous maps have been corrected against office copies and sent to press for reprint.

Total number of sheets sent for reprint during the year under report is 111. Total number of sheets still in hand is 39.

(5) *The Mapping Section.*—

(*a*) 124 modern topographical sheets were corrected and brought up-to-date against office copies and sent to press for reprint, seven sheets remain in hand.

(*b*) Press order proof corrections have been inserted on the original fair sheets of 177 topographical sheets after publication Corrections to ten more sheets are in hand.

(*c*) The original of the 64-mile Railway map of India, map of India showing districts and provinces, and six other miscellaneous maps were brought up-to-date and sent for reprint.

(*d*) 57 fair and print original sheets and contour patterns of various special maps were taken in hand during the year under report. 50 sheets have been completed and sent to press and seven are still in hand. These include maps prepared for census, railway, industrial, military and other departments. Trace originals of 43 maps have been prepared for military purposes.

(*e*) Minor corrections to 2,122 stock copies of modern maps were carried out for the Map Record and Issue Office.

(6) *The Office Copy Section.*—

(*a*) Additions and corrections received from various local authorities, have been entered on the existing "office copies" of 2,686 published sheets. 589 "office copies" of newly published or reprinted sheets have also been prepared during the year.

(*b*) The miscellaneous work of this section includes supply of authenticated copies of revenue and historical maps, revenue data from field-books and other records to officials and private persons and checking of area statements on fair sheets against Auxiliary Tables and keeping a record of these areas.

(7) *The Examining Section.*—This section is responsible for the examination of the sheets drawn by other sections in the office and also for the general scrutiny before publication of a large number of sheets drawn in other circles and drawing offices.

166 cases affecting 227 sheets have been examined during the year. Seven cases affecting thirteen sheets remain in hand.

In addition to the above current work, this section supplied scientific data to various officials, kept up corrections to Imperial Gazetteers, examined projections on copper plates of sheets in the Engraving Office, checked geographical names in various Survey of India publications, examined proofs of diagonal scales and of the Index to Chapter VI of the Topo. Hand-book, drafted corrections to various departmental hand-books and border specimens and carried out other miscellaneous work.

56. Engraving Office.—(1) *Engraving Section.*—The Engraving Office has been employed on the following during the year :—

(*a*) *India and Adjacent Countries*, scale 1:1,000,000. Of eleven sheets in hand, six have been completed and sent for publication, one is under final examination and the remaining four sheets are all well in hand. No new sheets were projected.

(*b*) *La Carte Internationale du Monde*, scale 1:1,000,000. Of seven sheets in hand, two have been published, three are well advanced, and the remaining two are in hand. Two new sheets were projected.

(*c*) *Southern Asia Series*, scale 1:2,000,000. Of eight sheets in hand, two (Colombo and Madras) passed through final examination and were sent for publication, four sheets are nearing completion, and the remaining are in hand. No new sheets were projected.

(*d*) In addition to above, periodic corrections have been carried out on the plates of all the general maps of India on various scales. The boundary symbols of all the 1 inch =32 miles index sheets have been made more prominent. A cover for the Copy Book of Lettering has been designed and engraved. Office copy corrections have been completed on twelve plates of the map of India and Adjacent Countries, scale 1 inch = 32 miles. Corrections and additions to 1/4 M India are in hand. A new large tint plate has been ruled for the Photo.-Litho. Office, size 40″ × 27″. A number of titles has been engraved on photogravure plates for the Photo. Society of India, and the Geological Survey. Twenty-one district maps and the 3″ plan of Calcutta have been revised and brought up-to-date. A half-anna postage stamp was drawn for H. M. Mint for reproduction.

(2) *Copper Plate Printing Section.*—29,876 impressions were pulled during the year compared with 32,502 during the previous year. 37% were scales and charts, 32% photogravures, 31% India Atlas sheets and miscellaneous. About 46% of the entire output was for extra-departmental purposes. In the Electro-typing Section 76 plates were dealt with.

57. Photo.-Litho. Office.—The number of maps printed in the *Litho.* Branch is considerably larger, though the number of pulls is slightly less, than was the case last year, but the out-turn may be taken as normal under post-war conditions.

The out-turn of the *Type Section* has fallen very considerably as compared with last year. This fall is in the main due to the fact that a large proportion of the work done has consisted of hand-books, &c., entailing heavy work on compositors, with the result that the machines have often been idle.

The out-turn of the *Process Engraving Section* shows a small rise, the smaller number of half-tone impressions being more than made up for by the increased number of line-block impressions.

During the year one new proving press driven by an electric motor has been installed and is working well.

A new process for obtaining photographically the tints on double lined roads and in water formations has been worked out and perfected by Shaikh Ghulam Nabi, in charge Powder Process Section. This process is found particularly useful in the case of complicated sheets.

The follwing tables briefly summarise the work of the office during the last 3 years :—

TABLE A.

WHOLE PHOTO.-LITHO. OFFICE.

1	2	3	4	5	6
Year.	* Cost of office.	Value of out-turn at cost-rates.	NUMBER OF SHEETS PRINTED.		
			Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*			
1919-20	2,20,643	4,19,636	786	3,118	3,904
1920-21	2,70,193	4,77,839	625	2,546	3,171
1921-22	**3,05,038**	**5,37,535**	**666**	**2,993**	**3,659**

*Does not include cost of chemicals, paper, &c., obtained from England.

TABLE B.—LITHO. BRANCH.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	TYPE SECTION OUT-TURN.		
				Pages or items published.	Copies printed.	Impressions pulled.
1919-20	3,013,622	122,522	727,255	4,656	1,564,552	2,742,584
1920-21	3,736,999	237,976	501,265	3,429	2,034,962	3,609,532
1921-22	**3,543,470**	**90,633**	**745,670**	**2,854**	**933,391**	**1,766,319**

TABLE C.—PHOTO. BRANCH.

	1919-20.	1920-21.	**1921-22.**
Negatives	6,658	5,786	**5,894**
Zinc plates	9,161	7,591	**7,395**
Photogravure plates	544	490	**475**
Half-tone blocks			
Line blocks			

58. Mathematical Instrument Office.—During the year (from 1st April 1921 to 31st March 1922) there was an increase in the demands made on this office for instruments, &c., (*vide* item 1 in para. 2 below), and the Store Section of the Office made a profit of Rs. 47,044 against a profit of Rs. 35,681 in 1920-21. There was however a decrease in the value of work done (*vide* item 6 in para. 2 below) and a loss of Rs. 38,910 occurred in the Workshop Section of the Office against a profit of Rs. 26,793 in 1920-21, but taking the two sections together there was a net profit of Rs. 8,134. Mr. Ferrier, the permanent Officer in charge, was on leave up to 6th September 1921 and Mr. S. Woodhouse acted for him up to that date, and Mr. P. A. Hughes acted for the latter as Officiating Works Manager. The loss in the Workshop Section was chiefly due to the following reasons :—

(*a*) Formation of an Optical Section under an Assistant Optical Manager, (Mr. R. C. Malcolm), on Rs. 800 per mensem who joined the Mathematical Instrument Office early in April 1921.

(*b*) Retention of the services of Mr. F. C. Lee (pay Rs. 500 per mensem) for a period of 8½ months after the arrival of Mr. Malcolm pending the termination of his agreement. Mr. Lee was employed on miscellaneous work during this period.

(*c*) Decrease in the demands on the Workshop by public offices for repair and manufacture work.

As regards (*a*)—The Optical Section is doing a great deal of very useful work for the military department such as repairing range-finders, binoculars, telescopes, compasses, sight dials, &c., in addition to the usual optical work for civil departments. In connection with the above this section is training a number of young Indians in optical work. This year (1922-23) the out-turn under these heads is much better and no further loss on account of this section is anticipated. When this section is well established, it should prove very profitable.

2. The following table shows the usual comparative figures for the last 3 years:—

	1919-20.	1920-21.	1921-22.
	Rs.	*Rs.*	**Rs.**
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	5,54,959	4,74,911	**5,32,768**
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	48,002	96,089	**1,18,445**
3. Value of instruments received from Government Officers when no longer required.	51,503	70,484	**58,743**
4. Book value of the stock of instruments, &c., in Serviceable Stores.	4,06,059	5,06,988	**6,91,499**
5. Book value of the stock of instruments, &c., in Repairable Stores.	79,057	1,07,873	**1,25,646**
6. Total value of work done in the Workshop ...	3,67,343	4,81,809	**4,20,408**
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	1,95,907	1,82,644	**1,76,123**
8. Value of instruments purchased locally ...	70,276	41,063	**11,296**
9. Value of instruments and materials obtained from England through the Director General of Stores.	1,57,694	2,98,795	**4,58,016**
10. Average No. of employees and their pay ...	No. 599 Rs. 1,28,770	No. 618 Rs. 1,77,655	**No. 628 Rs. 1,93,658**

3. During the year the stock of all the three stores (the Serviceable, the Repairable and the Material Stores), was twice taken as usual and the discrepancies noticed were duly adjusted.

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

59. Computing Office.—Professional Paper No. 18, "A criticism of Mr. R. D. Oldham's Memoir, *The Structure of the Himālayas and of the Gangetic Plain*, as elucidated by Geodetic Observations in India," by Lieut.-Colonel H. McC. Cowie, R.E., was published during the year. It is pointed out in this paper that, owing to the assumptions and limitations introduced by Mr. Oldham in his calculations, the conclusions drawn by him do not serve to simplify the problem of the Indo-Gangetic trough.

A large amount of computation and compilation was done in complying with both departmental and non-departmental requisitions. Special mention may be made of the geodetic report compiled for submission to the first General Conference held at Rome in April 1922.

Data were compiled for the prediction of tides for 40 ports for 1923 by means of the tide-predicting machine.

In addition, the tide-tables for 9 riverain ports for 1923 were completed from the diurnal charts.

The triangulation executed by Bt.-Major E. O. Wheeler, M.C., R.E., during the Mount Everest Expedition was computed, and the triangulation connecting the Madras Longitudinal Series with the Cuddapah triangulation was adjusted.

The preparation of a revised and extended 5th edition of the Auxiliary Tables of the Survey of India is in progress. Part III of this edition has been completed, and a small stock printed.

The revision of Chapter III (1914) of the Handbook of Topography is almost complete, but the publication is likely to be delayed owing to pressure of work in the printing office.

279 requisitions for data from departmental and non-departmental officials were complied with.

Triangulation pamphlets covering 60 degree sheets were printed and 50 issued in the course of the year.

Levelling pamphlet No. 62 was printed and issued, and levelling pamphlet No. 63 and the Mesopotamia levelling pamphlet are under reprint.

Type Printing Section.—The following were printed during the year:—

1. Records of the Survey of India, Volume XV, 1919-20.
2. Memoir on the Maps of Chinese Turkistān and Kansu (Sir A. Stein, K.C.I.E.).
3. Explorations in the Eastern Karakoram and the Upper Yārkand Valley (Lieut.-Colonel H. Wood, R.E.).
4. Tide Tables for Indian Ports, 1923.
5. 60 Triangulation Pamphlets.
6. Levelling Pamphlet No. 62 and addenda or slips to Pamphlets Nos. 34, 35, 39, 40, 45, 47, 53, 54, and 72.
7. Auxiliary Tables, Part III.
8. Appendix to Levelling of Precision.
9. The Auto-stereo plotter, a translation from the French of Paul Corbin. (Lieut.-Colonel H. McC. Cowie, R.E.).
10. Note on the stage reached by the Geodetic Operations of the Survey of India in 1920 (Lieut.-Colonel H McC Cowie, R.E.).

11. The following also are in hand:—

(*i*) Records of the Survey of India, Volume XVI, 1920-21.

(*ii*) Handbook of Topography, Chapter II, (Revised).

(*iii*) Author's Catalogue of Books of Trigonometrical Survey Office Library.

Observatories.—Meteorological observations were continued as usual, and the Omori Seismograph was in operation throughout the year.

Photographs of the sun were taken on 275 days, the sun being obscured on the remaining days of the year.

Preservation of Trigonometrical Stations.—745 stations were repaired by district officers at a cost of Rs. 4,943. Out of 361 districts from which reports were due, 22 failed to make returns.

60. No. 2 (Dehra) Drawing Office.—During the year under report the work of this office was carried on principally by six sections but a seventh section was formed towards the end of the year.

(1) *The Triangulation Chart and Cantonment Section.*—Deals with the fair-drawing of triangulation, levelling and index charts, and the publication, reprint and correction of cantonment plans. In addition to the ordinary work of this section, 36 maps, charts and diagrams were dealt with and sent to press and 149 sheets hand-coloured.

(2) *The Compilation Section.*—Deals with the compilation and fair-mapping of geographical maps on different scales. Two fair sheets on 1/M scale shown as in hand last year were completed and sent to press. Six sheets of rough compilation on 1/M scale were in hand at the end of last year, two more sheets were received during the year; of these two have been compiled and are being fair-mapped, two sheets have been sent to Calcutta to be engraved and four are in hand. Of the rough compilation of sheets on the 1/2 M scale, four were in hand at the end of last year; two have now been completed and sent to Calcutta to be engraved and two remain in hand. Four sheets of stump-shading were in hand at the end of last year, and five more were taken up during the year; out of these seven have been completed and two remain in hand. The fair-mapping of four of the seven half-inch sheets, which were in hand at the end of last year has been completed and they have been sent to press and three remain in hand.

(3) *The Stein Section.*—Deals with the fair-mapping of Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906-08 and 1913-15. Forty-three sheets of this series had already been published at the end of last year, three sheets have been published this year, and two are in different stages of publication. The fair-mapping of one sheet shown as in hand last year is still in progress. Eleven special triangulation charts and one levelling chart of this area were received during this year for fair-drawing and are in hand.

(4) *The Half-inch Section.*—Deals with the fair-mapping of half-inch sheets. Sixteen sheets were sent to press during the year and thirteen sheets are in hand, these with the seven sheets mentioned in the report of the Compilation Section make up the total of 36 sheets reported as in hand in last year's report.

(5) *The Examining Section.*—Examines the majority of the important sheets drawn in this office. 135 sheets have been examined during the year and 34 sheets are in hand.

(6) *The Cantonment Mapping Section.*—The section has been lately formed to help No. 20 Party (Cantonment) to clear off the arrears of cantonment mapping. 17 sheets have been received and are in hand.

(7) *The Map Record Section.*—Deals with the storage of originals and office copies of cantonment plans, triangulation and other charts and geographical maps, and keeps a small stock of maps published by the Department for occasional issue to the public and for departmental use. It also deals with the despatch of sheets issued from Dehra Dūn and with all correspondence on the subject.

The following is the summary of the work of the office during the year 1921-22 :—

Class of maps.	Balance of sheets on 1st October 1921.	Sheets received in 1921-22.	Sheets sent to press in 1921-22.	Balance of sheets in hand on 1st October 1922.	REMARKS.
Triangulation charts ...	18	75	76	17	
Levelling charts, scale 1/M	1	2	2	1	
Index charts to illustrate reports.	1	4	4	1	
Cantonment plans for publication.	93	84	143 (*a*)	34	(*a*) Completed and sent to press.
Cantonment plans for correction.	4	51	44 (*b*)	11	(*b*) Corrections carried out in both originals and office copies.
Cantonment maps fair-drawing.	...	17	...	17	
Miscellaneous maps, charts and diagrams.	1	62	42	21	
Colour guides of cantonment and other maps.	70	234	149	155	
Half-inch sheets ...	36	...	20	16	
GEOGRAPHICAL MAPS.					
Fair sheets, scale 1/M ...	2	2	2	2	
Rough compilation, scale 1/M	6	2	4 (*c*)	4	(*c*) Two sheets have been compiled and are being fair-mapped, and two sheets have been sent to Calcutta for engraved edition.
Rough compilation, scale 1/2M	4	...	2 (*d*)	2	(*d*) Sent to Calcutta for engraved edition.
Stump-shading, various scales	4	5	7	2	
Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906-08 and 1913—15, for publication on 2/M scale.	1	...	...	1	Out of the 5 sheets sent to press last year, three have been published and two are under publication.

Photo.-Zinco. Section.—During the year 1921-22, the work undertaken comprised :—

Cantonment maps.
Indexes and Triangulation charts.
Forest maps.
Maps, illustrative of Sir Aurel Stein's explorations.
Miscellaneous maps.
Extra-departmental maps.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Bromide prints.
1919-20 ...	1,414	2,087	316,114	562
1920-21 ...	1,430	1,911	436,996	447
1921-22 ...	**1,480**	**2,028**	**305,415**	...

61. Forest Map Office.—The classes of work entrusted to the four technical sections of this office have been described in a previous report; the distribution of work has been continued on the same lines, and the progress made during the year under report is described below :—

(1) *The Drawing Section.*—The progress of this section is shown in the table below :—

Class of map.	In hand on 1st October 1921.	Received during the year.	Drawn and sent for publication during the year.	In hand on 30th September 1922.	Published during the year.	Total number of copies printed.
(*a*) ...	8	80	81	2	54	23,551
(*b*) ...	94	33	73	54	33	
(*c*) ...	13	5	7	11	2	
(*d*) ...	4	8	12	...	16	
(*e*) ...	...	4	4	...	4	
(*f*) ...	19	45	32	32	36	
(*g*) ...	*5	1	5	...	4	
Total 1921-22.	***138**	**176**	**214**	**99**	**199**	.
Total 1920-21.	...	243	258	...	278	30,588

* The preparation of one of these maps was cancelled.

(*a*) Reprints of Forest maps on various scales.
(*b*) Forest editions, on the scale of 2 inches = 1 mile, of modern one-inch maps.
(*c*) Maps of Forest Circles and Divisions.
(*d*) Maps to illustrate working plans, &c.
(*e*) Maps and diagrams to accompany Administrative Reports.
(*f*) Forest maps from special surveys, mostly on the scale of 4 inches = 1 mile.
(*g*) Index and miscellaneous maps.

(2) *The Portfolio Section.*—Office copies of 215 maps and colour specimens of 74 maps were prepared; corrections on 149 sheets were completed, 84 office copies were coloured up and 1,758 sheets were coloured by hand for issue on indent. In addition this section corrected the forest information on 152 maps for the various Survey of India Drawing Offices which required them for compiling the half-inch and degree sheets.

(3) *The Map Record Section.*—The number of maps, diagrams and original fair sheets received for storage was 13,466; 4,401 maps, &c., valued at Rs. 8,623 were issued. Sales by book-transfer to government departments amounted to Rs. 5,705 for 2,814 maps; these figures show an increase of 832 maps and Rs. 2,005 above those for last year. Cash sales to the public amounted to Rs. 2,339 for 752 maps, an increase of Rs. 577 above the amount realized the previous year, attributable to the increase in the price of maps and not to a larger number sold.

(4) *The Book-Binding Section.*—This section dealt with 624 volumes for the Forest Research Institute, the value realized by book-transfer being Rs. 1,681, an increase of 137 volumes and Rs. 432, over the figures for last year. In addition, 2,423 maps of various sizes were mounted on cloth for issue.

62. The re-indexing of all the forest triangulation and traverse data lodged in this office, was taken up during the year for the purpose of preparing a comprehensive list of these records, and supplying printed copies to the Superintendents of the Survey Circles, in order that they may always have at hand, the fullest information as to the data available for their forest survey operations. More than half of this work has already been done, and it is hoped to issue the list in a few months' time.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

63. No. 3 Drawing Office (Northern Circle).—During the year 11 two-inch sheets out of 31, 38 one-inch sheets out of 75 and 1 half-inch sheet out of 8 previously surveyed, were fair-mapped by parties and submitted for publication.

Half-inch sheets compiled from one-inch sheets.—16 half-inch sheets, 14 of which were drawn in the Circle Drawing Office, have been submitted for publication during the year.

Modern material available.—The fair-mapping of 6 half-inch sheets, of which the component two-inch and one-inch sheets have been published or sent for publication, is in hand. In addition to the above, there are 19 half-inch sheet areas of which some of the component two-inch or one-inch sheets, though surveyed, have not been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch sheets.—During the year 8 quarter-inch sheets were fair-mapped in the Circle Drawing Office and submitted for publication.

Modern material available.—There are 20 quarter-inch sheet areas of which the component one-inch or half-inch sheets have been published; of these the fair-mapping of 11 sheets is in hand. There are besides the above, 13 quarter-inch sheet areas of which the component two-inch, one-inch and half-inch sheets though surveyed have not been published.

Special maps.—The colour patterns of Benares and Environs, Delhi and Vicinity in four sheets, Guide map of Mount Abu, Guide map of Mussoorie, scale four inches = 1 mile and Mussoorie City Map, scale twenty-four inches = 1 mile, were prepared and submitted for publication.

Hill-shaded sheets.—27 one-inch, half-inch and quarter-inch sheets were stump-shaded and submitted for publication.

Layer guides.—Nil.

Colour patterns and press order proofs.—The press order proofs of 68 one-inch, half-inch and quarter-inch sheets were prepared and submitted for publication. In addition to these the yellow and green colour patterns of 11 one-inch sheets were specially prepared during the year for future reprint purposes.

Miscellaneous.—The traverse plots of 17 "*mauzás*" in 41 sheets, scales sixteen and thirty-two inches = 1 mile, of the Gondá district, were supplied to and the cost of preparation recovered from the Deputy Commissioner, Gondá district.

64. No. 4 Drawing Office (Southern Circle).—During the year, 48 one-inch sheets previously surveyed and mapped and 7 one-inch sheets surveyed and mapped during the year by parties and received before the 30th September 1922 were finally examined and submitted for publication. There are no arrears.

Half-inch sheets compiled from modern one-inch sheets.—8 sheets were mapped and submitted for publication. There are 13 sheets in hand of which 1 will very shortly be submitted for publication.

Modern material available.—The material for 9 sheets of which the component one-inch sheets have not yet all been published has been received but the mapping has not yet been commenced. There are 10 half-inch sheet areas completely surveyed on the one-inch scale but of which all the component one-inch sheets have not yet been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch and old style sheets.—7 sheets were mapped and submitted for publication. There are 14 sheets in hand of which 2 will very shortly be submitted for publication.

Modern material available.—The material for 1 sheet has been received the mapping of which has not yet been commenced. There is 1 sheet of which the component half-inch sheets are under publication and for which the material has been asked for and in addition there are 9 sheets of which the areas have been completely surveyed but of which the component half-inch sheets have not yet been submitted for publication.

Reprint sheets.—1 quarter-inch sheet was corrected and submitted for publication and 1 quarter-inch sheet is in hand.

Colour patterns.—Were prepared and submitted to the Superintendent, Map Publication, for 107 sheets.

Hill-shaded sheets.—Were prepared and submitted to the Superintendent, Map Publication, for 31 sheets.

Layer guides.—Were prepared and submitted to the Superintendent, Map Publication, for 5 sheets.

Photo.-Zinco. work.—

Number of	reproductions	212
,, ,,	enlargements	195
,, ,,	reductions	221
,, ,,	Vandyke plates prepared ...	183
,, ,,	prints pulled	7,057

Special maps.—The three-inch military map of Secunderābād and Bolārum mapped by No. 6 Party was finally examined and submitted for publication. The one-inch military map of Shīrāz (Persia) the mapping of which was commenced in No. 6 Party was completed, finally examined and submitted for publication. The mapping of a four-inch military map of Būshire (Persia) which was commenced in No. 6 Party has been completed and the map will very shortly be submitted for publication. 15 two-inch sheets of the special forest survey of Hyderābād (Deccan) which were mapped by No. 6 Party were finally examined and submitted for publication.

Miscellaneous.—Preparation of index maps.

The usual training in drawing and typing was given to pupil surveyors and pupil draftsmen.

65. No. 5 Drawing Office (Eastern Circle).—The following are the numbers of sheets received from field parties during the year:—

Scale	12 inches to 1 mile	... ...	3
,,	¼ ,, ,,	... ...	4
,,	2 ,, ,,	... ...	8
,,	1 inch ,,	... ...	22
,,	½ ,, ,,	... ...	16
		Total ...	53

Two of the half-inch sheets have been retained in the office, as there is a possibility of further survey being obtained in them next year, and the other 51 sheets have been submitted for publication.

Half-inch sheets compiled from modern one-inch and old style sheets.—24 of these sheets have been in hand, including 4 which were drawn at Maymyo; 19 have been submitted for publication and 5 remain in hand.

Modern material available for half-inch mapping.—There are 18 modern half-inch sheets ready for drawing of which the component one-inch sheets have been published but the drawing of which has not yet been begun.

Quarter-inch sheets compiled from modern one-inch, half-inch and old style sheets.—Four sheets have been completed and submitted for publication.

Modern material available for quarter-inch mapping.—There are 5 quarter-inch sheets whose half-inch component sheets have been published, the drawing of which has not yet been put in hand.

Hill-shaded sheets.—62 sheets have been prepared and submitted. There are no arrears.

Layer guides.—One has been prepared and submitted. There are no arrears.

Colour patterns and press order proofs.—These have been submitted for 87 sheets and, in addition, the colour guides for 5 sheets have been prepared for reprint purposes.

66. No. 6 (Simla) Drawing Office.—The *Survey Section* has been employed on the compilation and fair-drawing of transfrontier maps on the one-millionth, half-inch and quarter-inch scales and incorporating additional information on sheets previously published.

During the year 30 quarter-inch sheets and 5 half-inch sheets were fair-drawn and submitted for publication and 3 quarter-inch sheets and 5 half-inch sheets were corrected and brought up to date and sent to press for reprint.

The *Army Section* is employed on the preparation and printing of maps and plans for the use of the Army and other Government Departments.

During the year 282 maps and plans were dealt with and 42,104 copies printed on the litho-printing presses.

67. Bengal and Bihār and Orissa Drawing Office.—(Imperial Standard Mapping Section). This section has been employed as usual on (*a*) the compilation from modern revenue survey material and from other maps and (*b*) the fair-mapping of the preliminary editions of modern one-inch sheets in colours pending their topographical revision. The sheets are completed from old material in cases where no modern work is available.

16 new sheets of Bengal and 14 new sheets of Bihār and Orissa have been fair-mapped and submitted for publication during the year. One degree sheet (preliminary edition) was also submitted for publication.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

68. Northern Circle. No. 2 Party.—A surveyor was deputed in November 1921 to carry out a survey on the eight-inch scale of the Headworks of the Western Jumna Canal for the Superintending Engineer of the Irrigation Circle. The survey of the area, which comprised 8·93 square miles, was completed in February 1922 at a cost-rate of Rs. 121·3 per square mile.

At the request of the City Board, Mussoorie, a surveyor was deputed during recess to carry out the survey of 40 acres on the scale 1 inch = 40 feet in the vicinity of Bhatta village. Work was commenced on 1st July 1922 and completed by the 25th September 1922 at a cost-rate of Rs. 16·7 per acre.

A section of this party completed the traverse of Allahābād City and Municipal areas for detail survey on the sixty-four-inch and sixteen-inch scales commenced in 1920-21 for the Allahābād Improvement Trust. 35·35 linear miles in an area of 1,324·8 acres, and 78·34 linear miles in an area of 31·91 square miles were traversed at cost-rates respectively of Rs. 79·7 and 18·0 per linear mile, while the number of plot charts for the sixty-four-inch and sixteen-inch areas prepared was 30 and 44 respectively. On completion of the above, the section was transferred to Imperial Delhi where they traversed the boundaries of demarcated areas of leased lands. 57·44 linear miles were traversed at a cost-rate of Rs. 58·8 per linear mile, and a schedule of the boundaries has been prepared for permanent record in book form for the Chief Engineer, Public Works Department, Delhi.

69. No. 4 Party.—At the request of the United Provinces Government and with the concurrence of the Benares State Durbar, an officer was deputed to examine and report on the disputed boundary between Benares State and United Provinces lying along the Ganges river. The dispute, which dates back to 1848, is due to the lateral movements of the river and reaches an acute stage whenever sufficient silt from the previous floods has been deposited on the sand banks to make them cultivable. The report, together with the original survey on the eight-inch scale and a spare trace of the disputed area, was submitted in due course through the proper channel. The expenditure in connection with the deputation was shared equally by the Benares State and United Provinces Government.

70. No. 20 Party (Cantonment).—The party completed the survey of the bāzār area in Bangalore, on the scale of 1 inch to fifty feet. This area comprised 35 sheets, the cost of survey and mapping of which, will be borne by the Bangalore Municipality. Regarding their preparation, mention might be made here of an unusual method adopted for classifying buildings. A distinctive style of hachuring is being used to illustrate the several kinds of roofing material; this has involved much laborious pen-work and for such cases in future a system of reference numbers, or letters, or grades of stippling by mechanical means, might be tried.

The cost-rates of this work are given on page 21.

71. No. 22 (Riverain) Party.—The party continued the work of traversing and laying down base lines. 2,269 linear and 413 square miles of minor traverse in the Indus, Chenāb and Panjnad riverain tracts

in the Muzaffargarh district were executed, 10,284 theodolite stations in 84 villages were fixed. 213 corners of 71 squares in 246 square miles were demarcated with permanent mark-stones on both banks of the Panjnad river in the Muzaffargarh district and Bahāwalpur State, to serve as bases for future survey and demarcation of boundaries and fields in the bed of the river. 27 missing stones of 9 old base lines along the Indus river in the Muzaffargarh district were relaid at the request of the Settlement Officer, Muzaffargarh. 1,154 plotted and 453 boundary *masāvis* (settlement mapping sheets) on the scale of 1/2,640, and 28 four-inch sheets were traced and supplied in time to the Settlement Officer, Muzaffargarh. Besides these, 564 boundary *masāvis* were partly compiled on the scale of one inch = 220 feet for the next season's work, and 257 miscellaneous traces were prepared, all the traverse stations marked during the field season were plotted on 28 four-inch sheets.

Lahore "Nazul" Land Survey.—The survey on the scale of 1 inch = 40 feet, undertaken towards the end of recess 1921 at the request of the Deputy Commissioner, Lahore in connection with the Lahore city extension scheme, was continued till the 10th November 1921; 33·5 acres were surveyed till the end of September 1921 and 16·0 acres were surveyed subsequently, making the final total area of 49·5 acres.

Khaur Special Survey.—This was undertaken, in continuation of the last year's work, for the Attock Oil Company at their request through the Deputy Commissioner, Attock district. The work consisted in surveying, on the eight-inch scale, with contours at 10 feet interval, the adjoining productive area to the south of the eastern extension, and re-demarcating the boundaries of the eastern and southern extensions dealt with last year. The topography was based on supplementary traversing. In all, 125 theodolite stations were laid out in 19·07 linear miles and 6 intersected points with heights were fixed for detail survey and boundary demarcation. The work was commenced in April and finished in July 1922. An area of 0·15 square mile was surveyed and 6·75 linear miles of boundary was re-demarcated. The last year's survey of the central portion, area 4 square miles, was corrected at the request of the Company to show new works that had been completed subsequently. Four miscellaneous traces were prepared, all the traverse stations marked, and intersected points were plotted on the 8-inch sheets of the last year.

72. No. 23 (Punjab Rectangulation) (old Sind-Sāgar) Party.—During the year under report the party was employed on rectangulation, in connection with the Punjab Government Sutlej Valley Canal and Colonization Project, in the Multān and Montgomery districts and Bahāwalpur State.

It having been decided that, to enable the whole area to be sub-demarcated in 3 field seasons, the Survey Department should only demarcate to 100-acre rectangles, only the area in which the exterior sides of 2,400-acre rectangles had been demarcated to 25-acre rectangles in the previous season was demarcated to 25-acre rectangles this season.

A total area of 1,588·2 square miles was rectangulated, 4,020 rectangles of 25-acre and 9,159 rectangles of 100-acre were laid out, and their corners marked with stones. An area of 1,992·1 square miles or 1,643·2 linear miles was traversed in advance for the purpose of laying down corners of 2,400-acre rectangles, and 646 such corners were located.

The country under rectangulation lies along the Sutlej river from Ferozepore on the north-east to the boundary of Sind on the

south-west. It is bounded on the north-west by the old bed of the Beās and the Chenāb and Indus rivers, and on the south-east by the boundary of the Bīkaner State and the old bed of the Ghaggar. A strip of country on both banks of the Sutlej river is well cultivated. The country to the north is a flat plain, covered with scrub jungle, very thick in many parts, and reserved as Government "Rakhs". The country to the south consists of a sand desert, studded with hillocks, which in some parts rise over 50 feet. Both these tracts are practically waterless.

In recess the party was employed on completion of the records of the rectangular survey, traverse computations and preparation of triangulation charts.

73. The Bhopāl Traverse Detachment.—Was formed on the 18th October 1921 with a view to traversing village boundaries for the cadastral survey of the Bhopāl State, on the scale 16 inches to a mile. The nature of ground under survey was undulating, and interspersed with rocky knolls. The country was partly covered with dense jungle and in other parts well cultivated.

Only 5 trained men were transferred from the Survey of India Department and all the other hands were entertained and trained. The work was entirely based on G. T. values. In all, 936 linear miles of main and sub-circuit traverses were executed, and 3,987 theodolite stations laid out, in an area of 327 square miles, along the boundaries and interior of 165 villages of the Durāhā *tahsīl* of the northern district; and 235 dressed stones were embedded on theodolite stations to serve as permanent marks for the future survey and demarcation. 355 sheets were plotted on the scale 16 inches to a mile, 24 four-inch sheets were traced, and the areas of 169 polygons were computed by universal theorem and planimeter, and supplied to the State Officials during the year. Besides this, several miscellaneous traces were prepared; and all the work done during the year was plotted on the scale 4 inches to a mile.

74. Southern Circle.—At the request of the Madras Government the settlement of the Mysore-South Kanara boundary was continued from the previous season.

Representatives of the Madras Government and of the Mysore Durbar, accompanied by Mr. J. O'B. Donaghey met at Gundia on the 5th January 1922.

Owing to illness Mr. Donaghey was replaced by Mr. V. W. Morton, who took over the work on the 13th February 1922.

About 61 miles of the boundary were finally settled during this season and a record prepared on prints of the Madras Forest four-inch survey sheets. The total length of the boundary finally settled up to date is now 85 miles.

The work has been temporarily stopped during season 1922-23, for financial reasons, but will probably be resumed during season 1923-24.

75. Lectures delivered by Lieut.-Colonel C. P. Gunter, O.B.E., R.E., during the year under report were as follows:—

Lecture on "Maps" and "Surveys" to the Intelligence Class at Poona on the 22nd April 1922.

Lecture on "Maps" and "Surveys in War" to an Intelligence Class at Bangalore on the 7th June 1922.

A course of instruction in Survey for Artillery Officers was held in Bangalore from the 11th to the 16th September 1922. Six officers of the Royal Field Artillery attended.

76. Eastern Circle.—In addition to his duties in the Imperial Department, the Superintendent, as Director of Surveys, Assam, held administrative charge of the Assam Survey Department, including the Assam Traverse Party, Drawing Office and Reproduction Office and the Assam Survey School. He also held administrative charge of the Maymyo Survey School, under the Government of Burma.

An Upper Subordinate officer, Mr. Bansi Ram, was placed on deputation under the Government of Burma in connection with the survey of the boundary between the Lushai Hills and Burma from the 1st January to 6th April 1922.

77. Trigonometrical Survey.—At the request of the Chief Engineer, Oudh and Rohilkhand Railway, a large scale survey of the Lucknow Station Yard and of the Railway property adjoining the Lucknow Cantonment was carried out during the year.

At the request of the Bombay Government, a detachment of No. 17 Party executed, in the Sukkur Barrage area, a network of levels involving 889 miles of levelling, the cost being borne by the local Government concerned, (*vide* pages 23 and 24). Work was also undertaken by the same party in the Nira right bank canals area, the cost being defrayed by the Bombay Government, (*vide* page 24).

In Bengal, certain lines of levels were run for the Nadiā rivers scheme and for the Irrigation department, (*vide* page 23).

Some minor triangulation was carried out by a small detachment of No. 15 Party in the Akora Practice Camp area at the request of the military authorities.

78. At the request of the Punjab Government, about 49,000 miles of close levelling has been undertaken in the Sutlej Valley Irrigation area. It is hoped that this, which is additional to the ordinary programme, will be completed in two seasons.

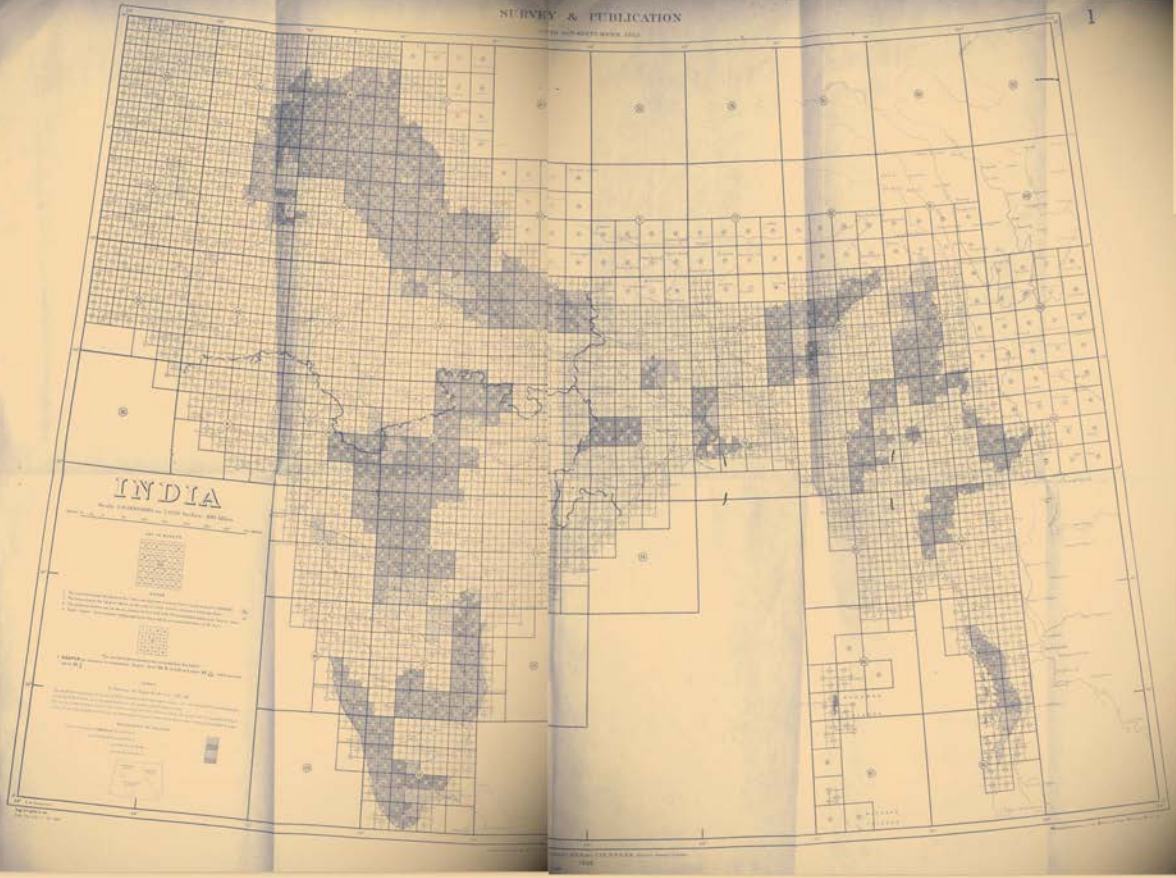
79. Head Quarter Offices.—The total out-turn of all extra-departmental publications during the year for the Army, for Local Governments and for other government offices are given in Table A of the Photo.-Litho. Office report on page 36, in the "Issues" table and in Table IV of the Map Record and Issue Office report on pages 30 and 31.

In addition to the special maps for other departments which are mentioned in para. 53 *(g)* on page 29, these extra-departmental publications include maps to illustrate the journals of the United Service Institution, various reports of government officials, maps for railway guides, and for posting in railway carriages, &c. The usual large numbers of weather charts for the Meteorological Department and of the photogravure and half-tone illustrations for the Archæological and other departments were also printed.

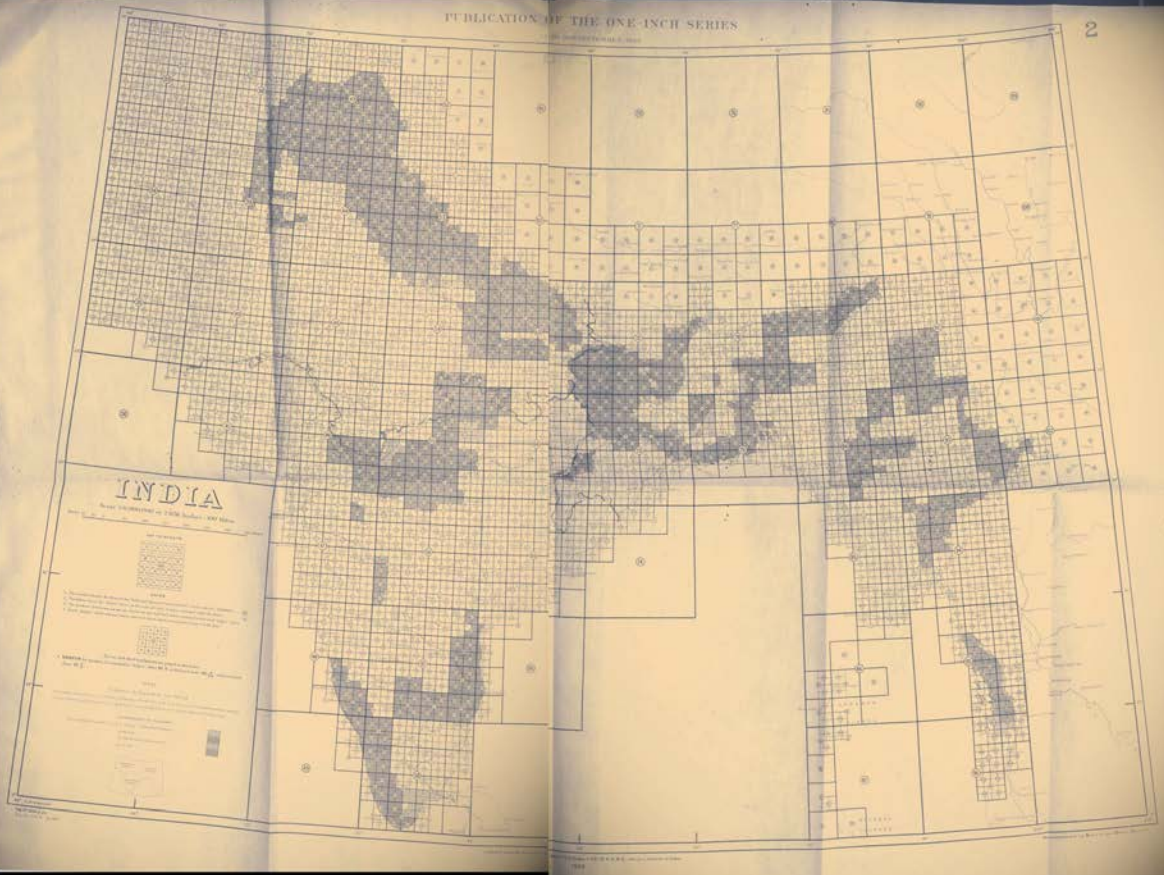
The work entailed by the preparation of originals for some of these special maps, in addition to their publication, is mentioned in the reports of No. 1 Drawing Office and of the Engraving Office on pages 32 to 35.

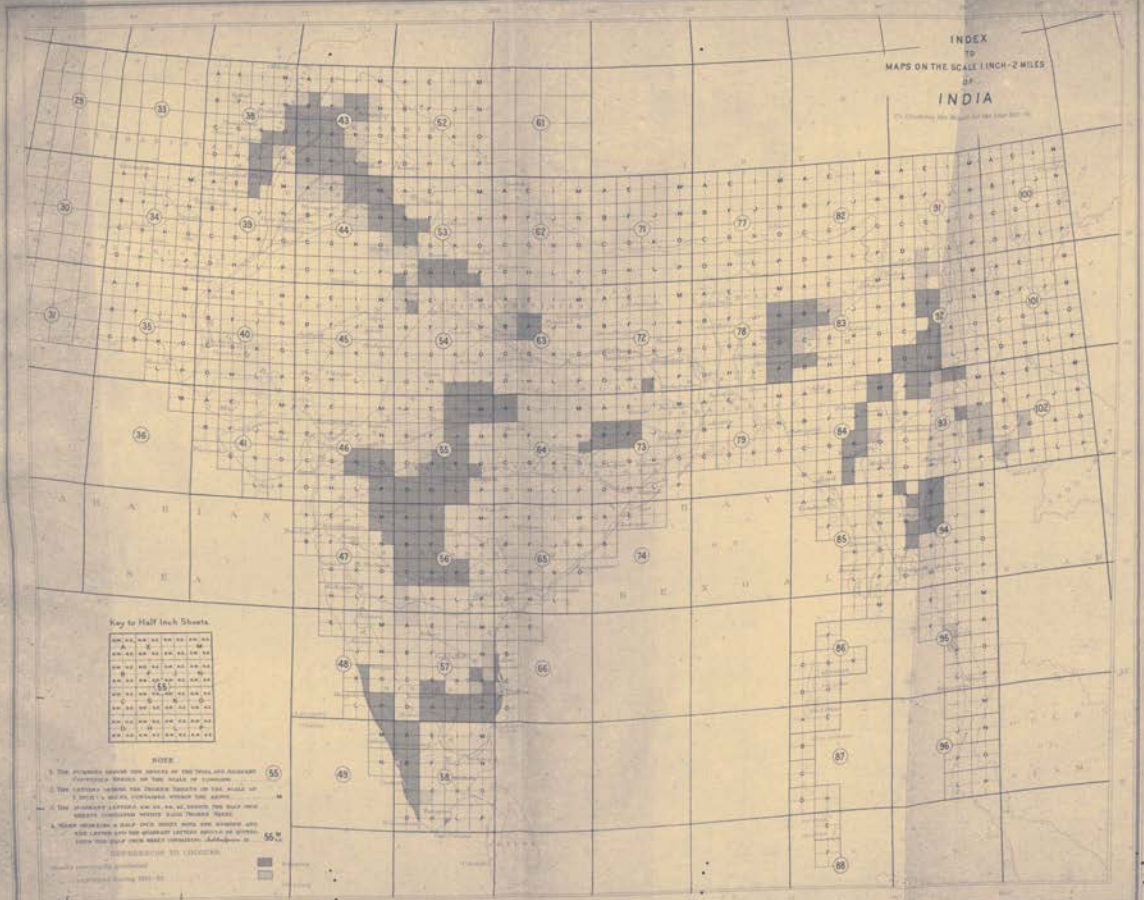
80. Mathematical Instrument Office.—The manufacture and repair of range-finders, binoculars, telescopes, sight dials, directors, prismatic compasses, scales, protractors, &c., for the military departments continued during the year under report. General repair and manufacture for civil departments is well up to date.

81. No. 6 (Simla) Drawing Office.—In addition to its normal work for the Army, this office has prepared maps and plans for the Commerce, Foreign and Political, Legislative, Meteorological and Public Works Departments and the Hydro-Electric Survey of India.


INDIA

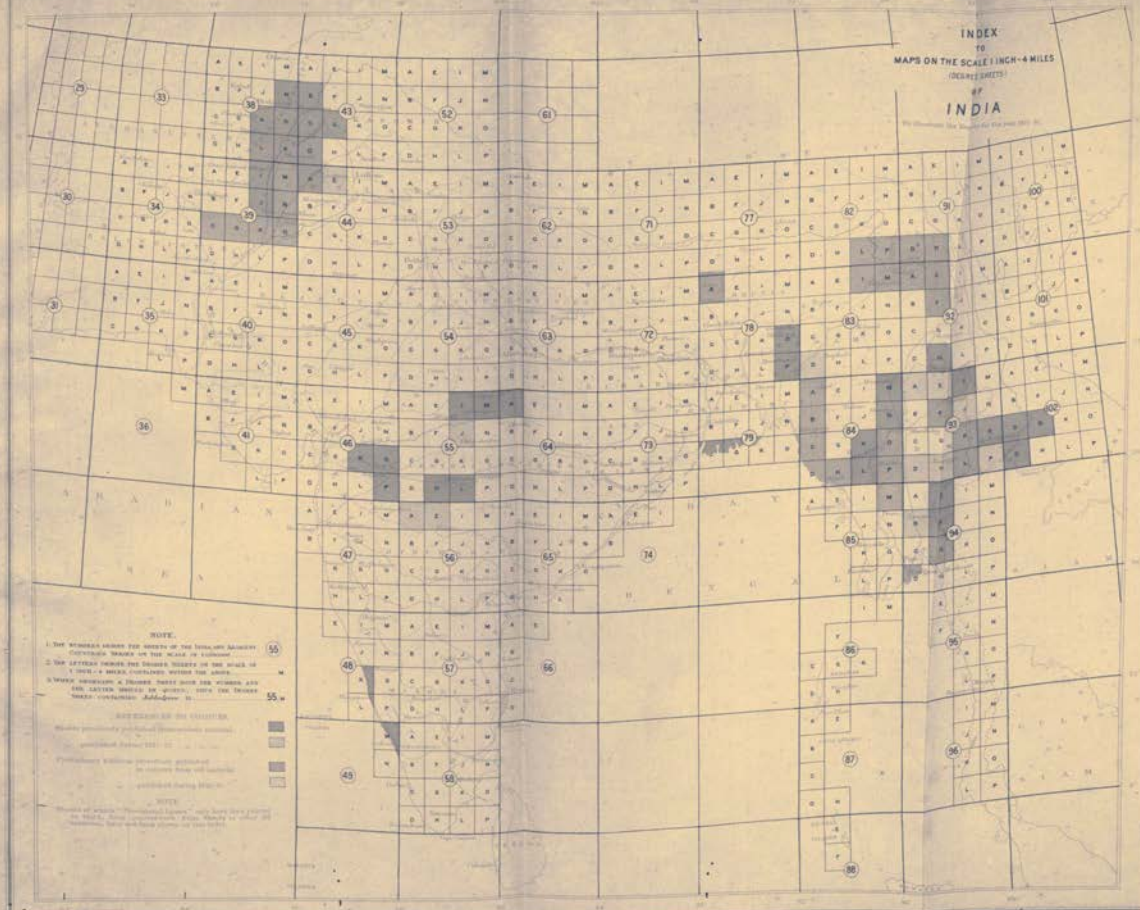
SURVEY & PUBLICATION.


INDIA


INDEX
TO
MAPS ON THE SCALE 1 INCH-2 MILES
OF
INDIA
Key to Half Inch Sheets.
A
B
C
D
E
F
G
H
I
J
K
L
NOTE
1. The numbers above the sheets of the Small and Ordinary Surveying Series on the scale of 4 inches
2. The numbers below the Degree Sheets on the scale of 1 inch to 4 miles, contained within the above
3. The quadrant letters NW, NE, SW, SE, denote the half inch sheets contained within each Degree Sheet.
4. Where required a half inch sheet with the quadrant and the letter and the quadrant letters should be given, thus the half inch sheet contained
55
55 NE
INDIA
Surveyed
Surveyed during 1911-12

HALF INCH SERIES.

INDEX
TO
MAPS ON THE SCALE 1 INCH = 4 MILES
(DEGREE SHEETS)
OF
INDIA


NOTE.
1. THE NUMBERS ALONG THE SIDES OF THE DEGREE SHEETS OF THE INDIA AND ADJACENT COUNTRIES DRAWN ON THE SCALE OF 4 MILES TO 1 INCH.
2. THE LETTERS ENCIRCLE THE DEGREE SHEETS OF THE SCALE OF 1 INCH = 4 MILES, CONTAINED WITHIN THE LIMITS.
3. WHERE NECESSARY A DEGREE SHEET HAS BEEN SUB-DIVIDED AND THE LETTERS ENCLOSED IN QUOTES, GIVES THE DEGREE SHEETS CONTAINED THEREIN.
55
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NOTE.

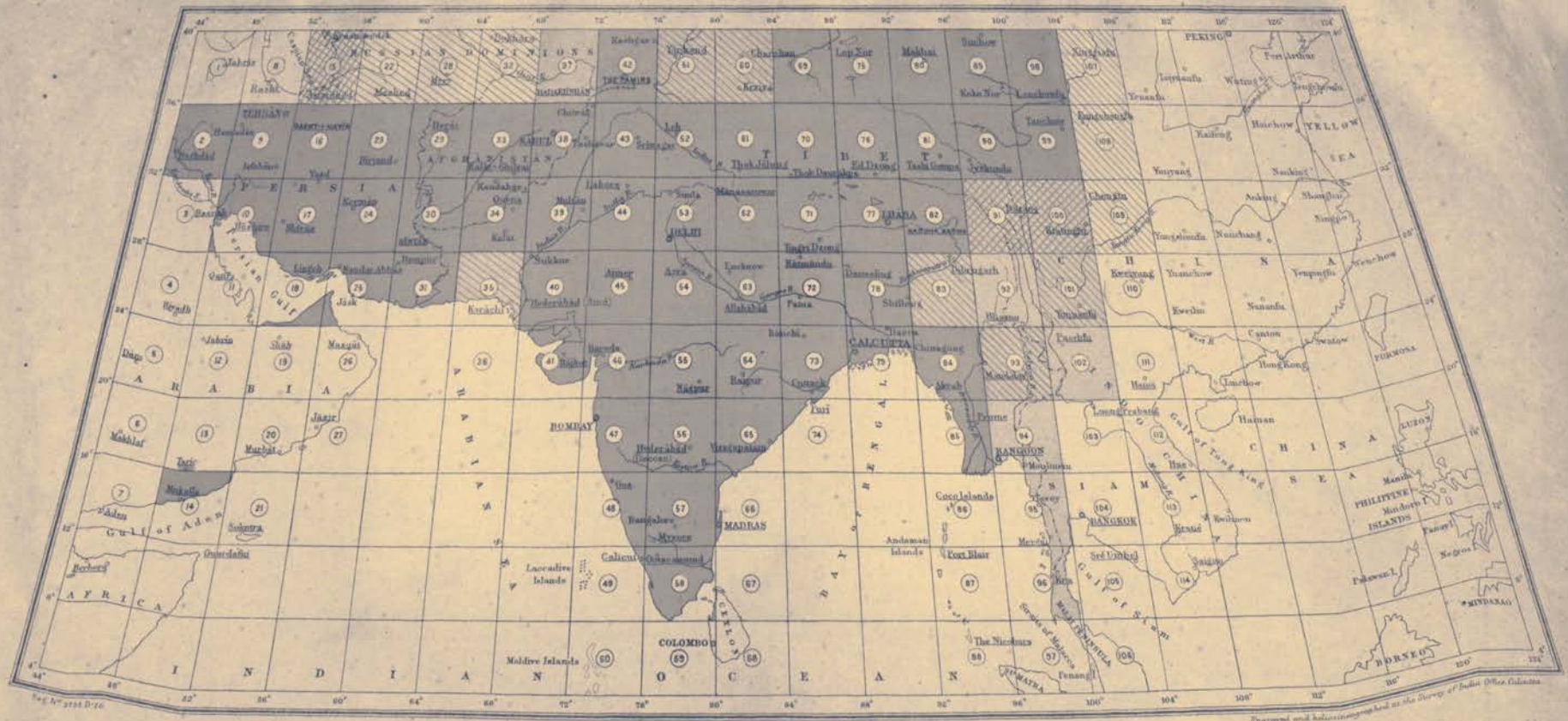
DEGREE SHEET SERIES

Scale 1 [illegible]

INDEX TO THE SHEETS OF THE

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1/1,000,000, or 1·014 inches to 16 miles.



Scale 32.000,000.

Miles 200 0 200 400 600 800 Miles.

NOTE.

The names underlined on this Index are the title names of the sheets, and their numbers are shown in circles. Sheets 35 and 36, 57 and 66, are published respectively as combined sheets.

REFERENCE.

To illustrating the Report for the year 1921-22

Sheets published without contours & hachures

with contours & hachures

Sheets published without

in hand.

Engraved and lithographed at the Survey of India Office Calcutta

5

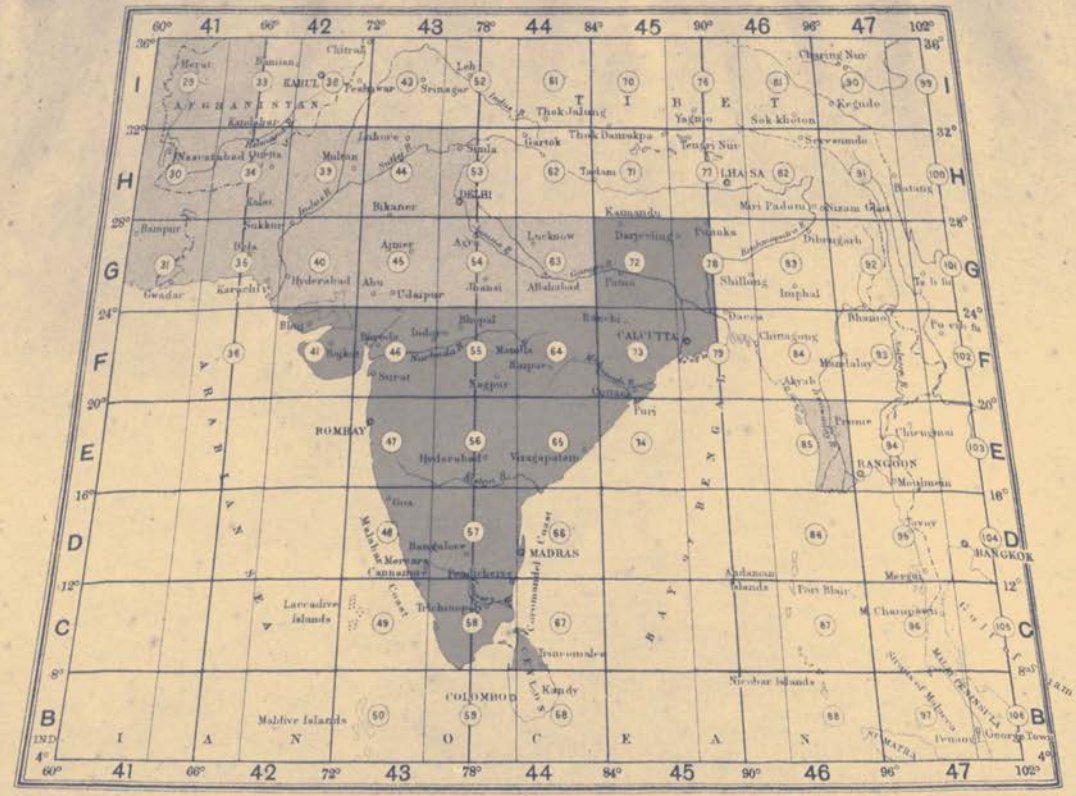
INDIA AND ADJACENT COUNTRIES SERIES

Scale 1:1,000,000.

INDEX TO THE SHEETS OF THE

CARTE INTERNATIONALE DU MONDE

on the Scale of 1:1,000,000.



EXPLANATION.

The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter and number corresponding to its position, *e.g.*, the sheet which includes Bombay is N.E-43

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.

Scale 1000000.

Miles 200 0 200 400 600 800 Miles

REFERENCE.

Sheets published

under publication.

in hand

To illustrate the Report for the year 1921-22.

Reg. No. 3431 D., 38.

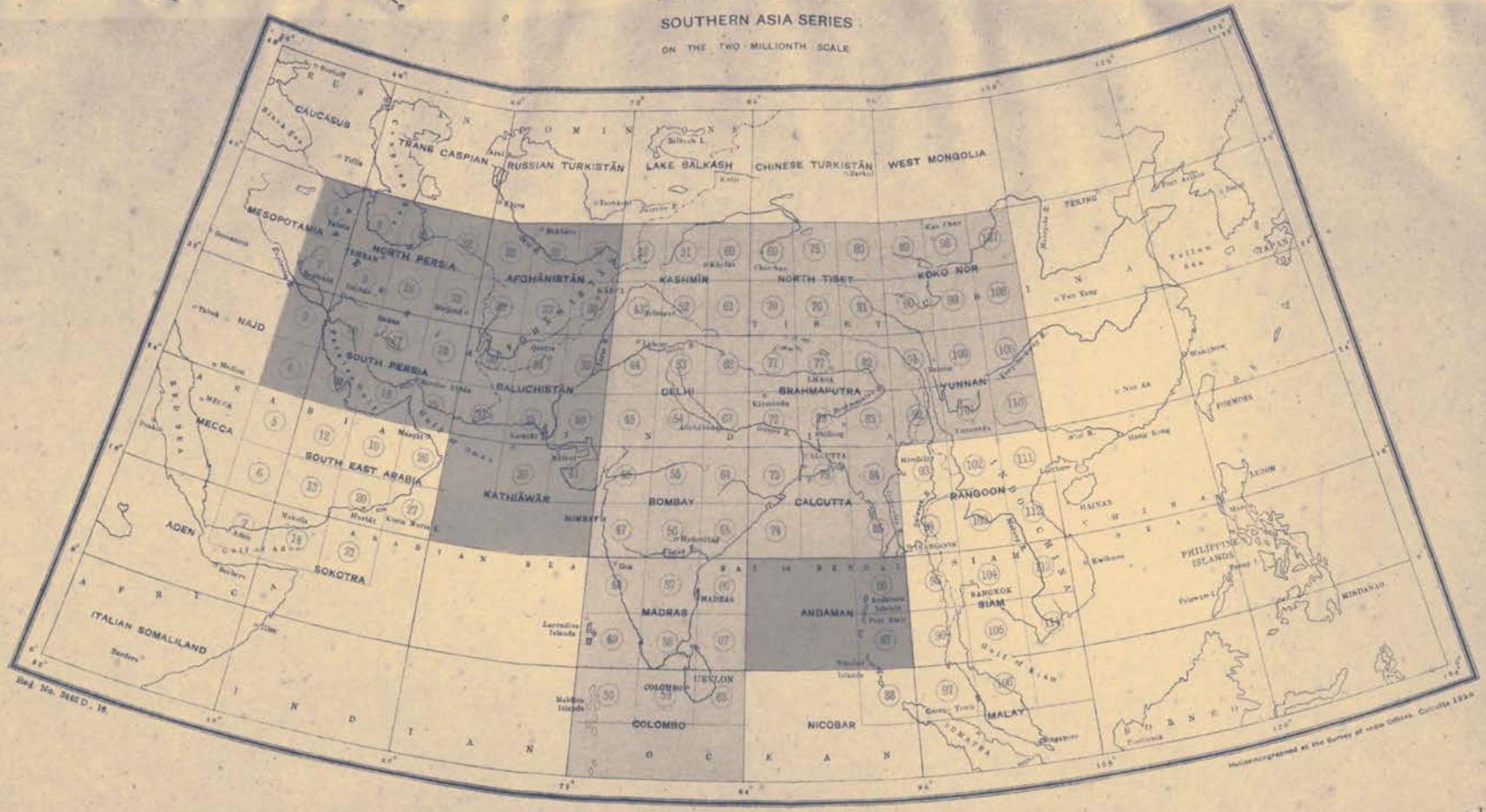
Hehio., S. I. O., Calcutta.

6

INTERNATIONAL SERIES

Scale 1:1,000,000.

INDEX TO THE SHEETS OF THE SOUTHERN ASIA SERIES ON THE TWO MILLIONTH SCALE



Red. No. 3442 D. 18.

Scale 40,000,000

Miles 200 0 200 400 600 800 1000 Miles

The E. portions of MESOPOTAMIA and NAJD sheets have been published for the present as outriggers to N. & S. PERSIA sheets respectively.

REFERENCE

To illustrate the Report for the year 1921-22

Sheets published with contours & layers

under publication

in hand

Photolithographed at the Survey of India Offices, Calcutta 1922

7

SOUTHERN ASIA SERIES

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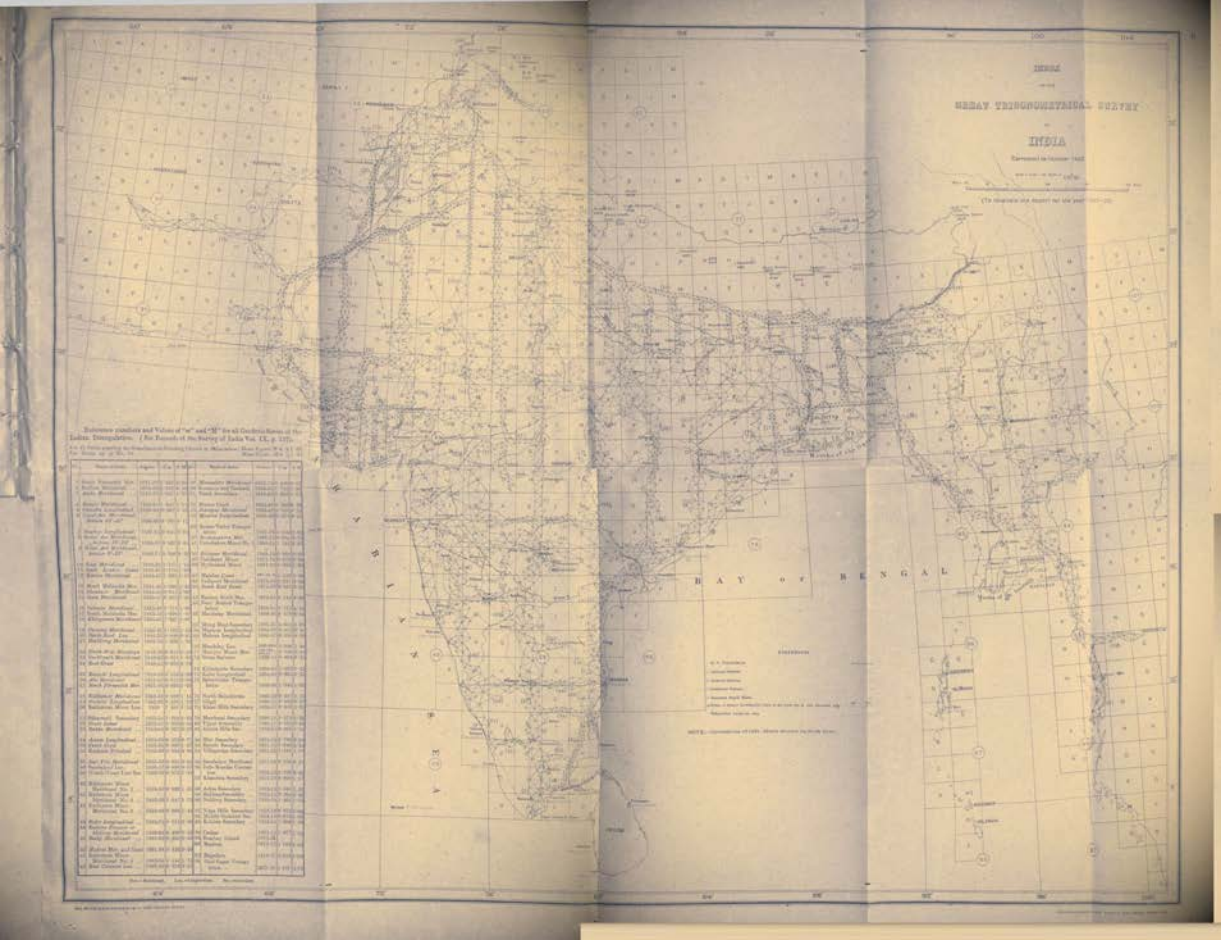
INDIA
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GREAT TRIGONOMETRICAL SURVEY
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INDIA
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